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FORM MORE SECTIONS!

By R. A. SEATON

Vice-President of the Society

The attendance at any annual meeting of the Society includes only about fifteen to twenty per cent. of the membership. The great distances to be traveled, the considerable expense involved and the time required make attendance impossible for four fifths or more of the members. These members can read in the JOURNAL the formal papers and discussions, but they miss much of the inspiration of the meetings, the personal contacts, and the opportunity to become acquainted with other engineering teachers, to exchange experiences and to discuss teaching problems with them informally outside the meetings. Yet many members regard the inspiration, the personal contacts, and the informal discussions as the most valuable features of the meetings.

These valuable features, now denied to so many of our members, can be made available to them, in large part, by Sectional meetings. Sections already organized include the Kansas-Nebraska, Kentucky, Middle Atlantic, Minnesota, New England, Ohio, and South Dakota Sections. Each of these sections, through its meetings is bringing to its members many of the advantages which otherwise would accrue only to those fortunate enough to be able to attend the annual meetings of the Society. One or more meetings are held each year, in rotation at the various institutions represented in the Section. Distances are comparatively short, auto travel with several passengers in each car is cheap and convenient, and meetings can be scheduled week ends so as to interfere but little with regular duties. Often they can be held in connection with other feature events, such as football games, thus providing a double incentive for attendance.

Members of sections which have been established are enthusiastic about their value. The meetings are well attended, they promote friendly relations between the faculties of the member institutions, improve the quality of engineering instruction, and stimulate interest in the Society. It is worthy of note that most of the institutions within the limits of Sections have an unusually large percentage of faculty members who are members of the Society.

The writer believes there are few, if any, engineering educational institutions in the United States or Canada which could not profitably cooperate with one or more other institutions in holding Sectional meetings. Rules governing Sections are to be found in Article VII of the Constitution, published in the Year Book. The procedure in organizing a Section is simple. The principal requirement is some member with the initiative to undertake the project.

Form more Sections!

NEW MEMBERS

ADAMS, OTTO V., Associate Professor of Civil Engineering, Texas Technological College, Lubbock, Texas. J. H. Murdough, W. E. Street.

AULICH, WITOLD M., Lecturer, Mechanics and Instructor in Design of Hydraulic Turbines and Pumps, Polytechnic of Lwow, Lwow, Poland. F. L. Bishop, Nell McKenry.

BACKER, LESLIE H., Associate Professor of Chemistry, Stevens Institute of Technology, Hoboken, N. J. F. J. Pond, F. D. Furman.

BAILEY, NEIL P., Associate Professor of Mechanical Engineering, University of North Carolina, Chapel Hill, N. C. E. G. Hoefer, G. M. Braune.

BARTON, WM. H., JR., Professor and Head, Dept. of Civil Engineering, Pennsylvania Military College, Chester, Pa. H. C. Berry, Francis P. Witmer.

BATCHELDER, DEAN E., Assistant Professor of Electrical Engineering, Colorado State Agricultural College, Fort Collins, Colo. Fred L. Poole, L. D. Crain.

BAUER, PAUL, Instructor in Mechanical Engineering, Purdue University, Lafayette, Ind. George W. Munro, John W. Geiger.

BRADFIELD, LANDIS R., Instructor in Social Science, Fenn College, Cleveland, Ohio. J. C. Nichols, Samuel Ward.

BROWN, GROVER C., Manager of Training, Industrial and Public Relations Dept., Bethlehem Steel Corporation and Subsidiary Companies, Bethlehem, Pa. M. C. Stuart, F. V. Larkin.

CASTLEMAN, JOHN R., Associate Professor of Engineering Drawing, Virginia Polytechnic Institute, Blacksburg, Va. L. O'Shaughnessy, E. B. Norris.

CLEVELAND, LAURENCE F., Instructor in Drawing, Northeastern University, Boston, Mass. George H. Meserve, Eliot F. Tozer.

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DEVINE, JAMES J., Assistant Professor of Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. G. K. Palsgrove, John G. Fairfield.

DOUGHTIE, VENTON L., Assistant Professor of Mechanical Engineering, Texas Technological College, Lubbock, Texas. J. H. Murdough, J. C. Hardgrave.

DOUGLAS, JOHN A., Instructor in Electrical Engineering, Stevens Institute of Technology, Hoboken, N. J. Frank Stockwell, H. C. Roters.

DU PLANTIER, DONALD A., Assistant Professor of Structural Engineering, University of Alabama, Tuscaloosa, Ala. G. J. Davis, F. L. Bishop.

EGRY, C. ROBERT, Instructor in Machine Design, Purdue University, Fafayette, Ind. John A. Sauers, George W. Munro.

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SALMA, EMANUEL A., Instructor in Mechanical Engineering, The Cooper Union, New York City. G. F. Bateman, H. F. Roemmele.

SCHMIDT, HARRY P., Instructor in Physical Elements of Engineering, Pratt Institute, Brooklyn, N. Y. S. S. Edmands, E. P. Lambe.

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TEICHMANN, F. K., Instructor in Aeronautical Engineering, New York University, New York City. Chas. W. Lytle, Joseph W. Roe.

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UHRIG, L. VERNON, Instructor in Civil Engineering, The Rice Institute, Houston, Texas. L. B. Ryon, Jr., Wm. E. White.

VAN DEN MEERSCHE, ANDRE J., Instructor in Electrical Engineering, University of Ghent, Ghent, Belgium. H. M. Turner, Chas. F. Scott.

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WARNER, ROBERT W., Associate Professor of Electrical Engineering, University of Kansas, Lawrence, Kans. H. W. Anderson, D. C. Jackson, Jr.

WEINBERG, EDWARD F., Professor of Mathematics, Rollins College, Winter Park, Fla. F. L. Bishop, Nell McKenry.

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ZELNER, OTTO S., Associate Professor of Civil Engineering, University of Minnesota, Minneapolis, Minn. O. M. Leland, Frederic Bass.

114 applications for membership have been received at this time, November 5, 1930. Have you asked your colleague to share with you the benefits of membership in this Society? An application blank is printed on page 259. Have him fill this out and send it together with check for $5.00 for 1930–31 dues to the secretary F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

COLLEGE NOTES

Alabama Polytechnic Institute.—The new Ross Chemical Laboratory building was completed and dedicated in May of this year. It was named in honor of the late Dr. B. B. Ross who had been head professor of Chemistry at the Institute for thirty-seven years and who died only a few weeks before the building was completed. The floor space is approximately forty thousand square feet and furnishes space for offices for the staff, an auditorium, large student laboratories, and a number of private and research laboratories. The service facilities and mechanical equipment are very complete.

A department of Textile Engineering was established a year ago offering four degree courses leading to a degree and a short course of two years. A new Textile Building is nearing completion and a large amount of equipment will be installed during the present semester. The building is 300 feet long by 65 feet wide two stories and basement, of standard mill construction. Equipment for cotton, rayon and silk will be installed and considerable research work will be undertaken.

A new shop building 250 feet long by 50 feet wide is practically finished and will be in use within a month. In addition to office and class room space it provides a plant service repair shop and storage, and the following shops for class work: Auto mechanics, Carpenter and Pattern, Cabinet and Finishing, and Sheet Metal. Some of this equipment is provided especially for students taking the course in Industrial Arts for teachers.

Beginning this year an option in Aeronautical Engineering is offered in the Mechanical Engineering course. About forty students are registered for the option and laboratory equipment is being assembled for the work. Lieut. Volney C. Finch, a retired naval officer, is in charge of the course. Lieut. Finch has had advanced training in Aeronautical Engineering at Massachusetts Institute of Technology and at the Naval Academy, and thirteen years of experience in naval stations much of which time has been spent as instructor at naval air stations and on ship board.

University of Arkansas.—Professor C. H. Kent, head of the Mechanical Engineering Department, has been granted a year's leave of absence for graduate study in the University of Wisconsin and Professor Marshall E. Farris of the Texas Technological Col-

lege, Lubbock, Texas, has been appointed temporary head of this department. Professor Farris is also on leave from his institution.

Last June Mr. J. A. Blackhurst, instructor in Civil Engineering, resigned to go into professional work and Mr. R. C. Wray, B.S., Carnegie Institute of Technology, 1929, C.E., Virginia Polytechnic Institute, 1930, was appointed to fill the vacancy.

Mr. R. F. Richmond, instructor in Drawing and Architecture, resigned to continue graduate work in Architecture and Mr. R. J. Hammond, who received his degree of Bachelor of Architecture from University of Texas in 1929 and his M.S. in Architecture in 1930, was appointed and has assumed his duties.

Armour Institute of Technology announces that: Thomas E. Doubt, Ph.D., Associate Professor, has been appointed Professor of Experimental Physics; Henry L. Nachman, B.S., M.E., Associate Professor, has been appointed Professor of Thermodynamics; Edwin S. Libby, B.S., M.E., Associate Professor of Experimental Engineering, has been appointed Professor of Refrigeration Engineering; Oliver C. Clifford, Ph.D., Associate Professor, has been appointed Professor of Electrical Engineering; Lynn E. Davies, B.S., Assistant Professor, has been appointed Associate Professor of Experimental Engineering; James S. Thompson, Ph.D., Instructor, has been appointed Assistant Professor of Physics; Charles G. Beersman, formerly Chief Designer for Graham, Anderson, Probst and White, has been appointed Associate Professor of Architectural Design; Russell H. Ewing, A.B., LL.B., A.M., has been appointed Assistant Professor of Economics; Joel M. Jacobson, B.S., has been appointed Instructor in Civil Engineering.

University of California.—By action of the Academic Senate and the Regents of the University during the past months the former College of Civil Engineering and the College of Mechanics here have been merged into the College of Engineering. The College of Mining retains its identity as such.

The College of Engineering comprises the Departments of Civil, Mechanical, Electrical and Irrigation Engineering, each with its Chairman. At the present time these chairmen are: C. Derleth, Jr., Civil, who is also Dean of the College of Engineering; B. M. Woods, Mechanical; L. F. Fuller, Electrical; B. A. Etcheverry, Irrigation.

Professor C. L. Cory, formerly Dean of the College of Mechanics, is on leave of absence until January, 1931, due to illness.

C. F. Garland, Assistant Professor of Mechanical Engineering, formerly of the Universities of Colorado and Yale, is a recent acquisition in the division of machine design and mechanism.

Carnegie Institute of Technology.—The following persons have been added to the faculty of the College of Engineering, Carnegie Institute of Technology: James W. Ballard, instructor in Physics, John F. Eckel, assistant, Bureau of Metallurgical Research, George P. Halliwell, assistant professor of Metallurgy, D. Roberts Harper, III, assistant, Coal Research Laboratory, Hervey C. Hicks, assistant professor, Mathematics, Carl L. Jones, instructor, Mechanical Engineering, John C. Kohl, instructor, Civil Engineering, Dr. H. H. Lowry, director, Coal Research Laboratory, Glenn C. McCombs, instructor, Drawing and Descriptive Geometry, Joseph C. Rintelen, Jr., instructor, Chemical Engineering, Edward A. Saibel, assistant professor, Mechanics, George B. Thorp, instructor, Mechanical Engineering, William B. Warren, assistant, Coal Research Laboratory.

Dr. Emerson M. Pugh has returned to the faculty after a leave of absence during which he secured his doctorate in Physics at the California Institute of Technology. Michael S. Schonvizner, who taught in the department of Drawing and Descriptive Geometry last year, has been added to the faculty of the department of Electrical Engineering. Dr. T. R. Alexander, of the Chemistry department, has returned from a year of study and travel in Germany.

Under the direction of Dr. H. H. Lowry, formerly of the research laboratories of the Bell Telephone Company, New York City, the recently founded Coal Research Laboratory is rapidly being organized. Dr. Lowry has secured several members of his technical staff and research work will get under way this fall. The new laboratory is located in Engineering Hall in a new annex on the north side of the building.

A Third International Conference on Bituminous Coal has been announced for November, 1931. President Thomas S. Baker expects to be in Europe this fall in connection with its organization.

Students in aeronautical engineering will soon have the wind tunnel laboratory at their disposal. Final work is being done on the tunnel at the present time.

The department of Mining and Metallurgy is offering graduate courses in metallurgy this fall for the first time. The work will lead to the M.S. and the Ph.D. degrees. Among the eleven students who have enrolled for this advanced work are four lieutenants of the United States Navy. Dr. V. N. Krivobok, who will direct the study, made a tour of European universities this summer in which similar courses are given.

Case School of Applied Science enters immediately upon a development of graduate evening courses as announced by Dr. William E. Wickenden, president. This new field of work, entirely under the direction of the Case trustees and faculty, opens at once

with three courses. However, the Case administration anticipates a gradual growth of the graduate courses until there will be a complete curriculum offered to young men who are college graduates and who desire further study in the late afternoon or evening.

The courses offered this semester include: Advanced Structures by Prof. Fred Plummer; Modern Physics by Prof. Christian Nusbaum; and Oscillating Circuit and Vacuum Tube Theory by Prof. John Martin.

Such graduate courses are not to be confused with the *undergraduate* courses given at Cleveland College. The new department of graduate evening courses under the Case managemnt will accommodate, both in day and evening classes, many men now possessing bachelor's degrees and wishing to continue their education while employed in Cleveland industries.

Columbia University.—Joseph Warren Barker has been appointed to succeed George B. Pegram as Dean of the School of Engineering. Professor Pegram will continue in his capacity as Executive Officer of the Department of Physics and also devote time to research. In the Department of Mechanical Engineering Professor Frank Lewis Eidmann and Associate Professor George B. Karelitz were appointed to carry on the work formerly given by Assistant Professor Lincoln deG. Moss and Assistant Professor Charles W. Thomas.

The Cooper Union.—The current term opened on October 7 with the usual complement of classes. Both Day and Night Freshman classes in Engineering have been chosen from much larger groups taking the entrance examinations than in preceding years.

In keeping with the policy of intensification rather than of expansion, there have been the following additions to the staff: Department of Chemical Engineering, Mr. Allan L. Tarr, instructor in Metallurgy; formerly metallurgist with the General Electric Company at Philadelphia. Department of Civil Engineering, Mr. C. O. Roth, Jr., instructor in Civil Engineering; formerly instructor at Drexel Institute. Department of Machine Design, Mr. M. St. John Bernner, instructor in Mechanical Drawing; formerly of the Engineering Societies Employment Service. Department of Mechanical Engineering, Mr. E. A. Salma, instructor in Mechanical Engineering; formerly with the United Electric Light and Power Company.

Machinery rounding out the equipment in the various departments is reported as follows: Department of Civil Engineering, 300,000 lb. Emery Hydraulic Testing Machine. Department of Electrical Engineering, in the Alternating Current Laboratory,

Three Motor Generator Sets, with Control Panels. Department of Mechanical Engineering, Sturtevant Blower and Test Duct, Forced and Induced Draft Fans in connection with Laboratory boiler.

The Department of Chemical Engineering continues its work for graduated students employed in the industry by announcing a course of lectures on Unit Operations of the Chemical Engineering Industry, to be given by Professor Albert B. Newman, Head of the Department. Over one hundred applications have been received from men employed in the industry, as well as from graduate students in neighboring colleges.

Under the combined auspices of the Departments of Physics and Chemical Engineering, a course of evening lectures on Modern Physics is given this year by Professor Karl F. Herzfeld of the Johns Hopkins University. The first of these lectures was given on October 7 to an audience completely filling the lecture room of the Department of Physics. Admission to this course was supervised, graduation from a recognized college and a working knowledge of the calculus being the fundamental requisites.

On March 3, 1930, the Daniel Guggenheim Fund for the Promotion of Aeronautics made an appropriation of $300,000 to the **Georgia School of Technology**, to establish a Department of Aeronautical Engineering. The new Department opened in the fall of 1930 in a specially designed building, containing a wind tunnel, surge tank, and other equipment for aeronautical testing and experiment.

The course in aeronautical engineering will include four years of college work, based on the regular entrance requirements for engineering students, and will lead to the degree of B.S. in A.E. The object of the course is to train men in aeronautical research and in the design and construction of aircraft.

Iowa State College.—T. R. Agg, professor of highway engineering, has been appointed assistant dean and director of engineering, and is sharing the administrative duties with Anson Marston, dean.

Prof. F. E. Johnson, formerly head of the electrical engineering department at the University of Kansas, Lawrence, took up similar duties Sept. 1. He is filling the position left vacant by the resignation of Prof. F. A. Fish, who because of health, resigned as head of the department to become a full time teacher.

The department of chemical engineering increased its teaching staff this fall by the addition of Prof. F. C. Vilbrandt, who was formerly with the University of North Carolina.

Other new appointments to the engineering staff were: 14 in-

structors, 7 graduate assistants, 2 fellows, and 1 assistant, which with the two full professors, make a total of 26 new appointments. The total number of full and part time staff members, including the Extension Department and the Experiment Station, is 113.

Preliminary enrollment figures indicate an increase of 5 to 10 per cent. in both freshmen and upper engineers.

Iowa State College granted to the class of 1930 engineers the following degrees: 186 bachelor of science, 25 master of science, 17 professional, and 4 doctor of philosophy.

University of Iowa.—New appointments to the engineering faculty include Dr. W. M. Young and Mr. J. L. Potter. Dr. Young had his undergraduate training as well as graduate at the University of Illinois. He comes as associate professor of electrical engineering from the Texas Technological College at Lubbock, where he held a similar position. Mr. Potter received his B.S. and M.S. degrees at Kansas State College and comes as an instructor in electrical engineering. F. T. Mavis was promoted to be associate professor of Mechanics and Hydraulics and R. M. Barnes to be associate professor of Mechanical Engineering. R. R. Whipple was promoted to be assistant professor of Electrical Engineering.

The electrical engineering department has taken over the building formerly occupied by the chemistry and pharmacy departments, which now becomes the electrical engineering building. It is a three story building approximately 160 x 80 feet in plan. Obsolete equipment has been replaced with new so that the teaching and research facilities of the department have been made more adequate. The building has been remodeled and houses the circuits and machinery laboratory (100 x 40 feet), the communication laboratory (40 x 45 feet), the illumination laboratory, the high tension laboratory, the communication research laboratory, the standardizing laboratory, the instrument room, the mechanician's shop, class rooms, offices, and a large lecture room with broadcasting installation over WSUI. Much of the broadcasting of class lectures in English is done from this room.

Plans are nearly complete for the new mechanical engineering laboratories building, for which bids will be called within the next few weeks. This building will embody several new laboratory features, particularly in the arrangement and facilities of the manufactures laboratories.

Work on the extension of the large channels at the hydraulics laboratory has been temporarily halted and probably will not be completed until next summer.

The registration in the College of Engineering showed an eight per cent. gain over last year, which was confined entirely to the upper classes. The accretions by transfer increase each year, being about 40 per cent. greater than last year. These transfers are chiefly from arts colleges and junior colleges in the state, although a few from other technical schools and more distant arts colleges. Of the present sophomore and junior classes 20 per cent. and 17 per cent. respectively transferred to Iowa this fall. The result of these accretions is that the present senior class is 99 per cent. as large as last year's junior class; the present junior class 97 per cent. as large as last year's sophomore; and the present sophomore class 94 per cent. as large as last year's freshman class, notwithstanding 12½ per cent. of the total of these classes were dropped for deficient scholarship.

An unusually large number of students who had completed one or more years of their class returned this fall (owing probably to employment stringency) to complete their courses. These constitute 5 per cent. of the three upper classes, the number of such in the senior class being 10 per cent.

The enrollment of the Engineering Division of the **Kansas State Agricultural College** continues slightly above the one thousand mark. For the year 1929–1930, it was 1090 with prospects for about the same enrollment during the present year.

Relatively few faculty changes have taken place. Professors R. H. Driftmier, R. S. Sink, and W. H. Sanders have resigned, Professor Driftmier to become head of the Department of Agricultural Engineering at the Georgia State College, Professor Sink to go to the University of Wyoming, and Professor Sanders to enter private business. Professor B. B. Brainard of the Department of Mechanical Engineering is spending a leave of absence for one year at the Massachusetts Institute of Technology in advanced study. Professor L. B. Smith of the Department of Architecture is doing advanced work at Harvard University.

Professor R. G. Kloeffler, head of the Electrical Engineering Department, is back on duty after a year of advanced study at the Massachusetts Institute of Technology and Harvard Graduate School of Business Administration.

Since the completion of the new power plant for the college more room has become available for the Department of Mechanical Engineering, and several important items of laboratory equipment have been added including a Diesel engine, a water-tube boiler, and a separately fired superheater.

Lafayette College.—Dean Donald Bishop Prentice, M.A., M.E., has been elected president of Rose Polytechnic Institute, Terre Haute, Indiana. The Dean whose resignation was officially accepted by the Board of Trustees, will take up his new duties in February, after completing this term in his present capacity.

Charles W. Macdougall, Assistant Professor of Mining Engineering, has been granted a leave of absence for one semester to recover his health. During his leave Mr. A. H. Fay will assume his duties.

Former Associate Professor William S. Lohr has been promoted to a full Professorship in the Department of Civil Engineering.

Former Associate Professor P. B. Eaton has been promoted to full Professorship in the Department of Mechanical Engineering.

Mr. D. L. Arm a graduate of Lafayette College in the class of 1930 has been engaged as Instructor in Mechanical Engineering.

University of Maine.—Among the engineering faculty members who attended the annual meeting of the Society for the Promotion of Engineering Education at Montreal in June, were C. A. Brautlecht, Paul Cloke, E. M. Dunham, W. S. Evans and E. H. Sprague.

Earl M. Dunham, of the Department of Engineering Drafting, attended the two-weeks Summer School held under the direction of the Society for the Promotion of Engineering Education at Pittsburgh, Pa.

Mr. Wilbur E. Tomlin has been appointed Instructor in Chemistry to succeed Mr. E. S. Durgan who resigned at the close of the past academic year. Mr. Tomlin holds an A.B. degree from Kentucky Wesleyan which he received in 1926, and is a candidate for a master's degree at Columbia University where he has done graduate work in Chemistry during the summers of 1928, 1929 and 1930. Mr. Tomlin came here from Mattoon High School, Illinois.

Mr. Joseph C. Twinem has been appointed Instructor in Civil Engineering to succeed Mr. W. H. H. Newell. Mr. Twinem is a graduate of Massachusetts Institute of Technology, and studied geology at the University of Wyoming during the past summer. In addition to civil engineering courses he is teaching Engineering Geology, the need of which has been felt in this college for some time.

There was authorized last spring a project which may be of general interest to the readers of "College Notes." This project was an extensive survey of the road materials of the State of Maine, and is a cooperative project between the Maine State Highway Commission, the Coe Research Fund Committee and the Maine

Technology Experiment Station. Its object is to secure as definite information as possible concerning the location, character, suitability and quantity of deposits of sand, gravel and rock. These deposits will be shown on sectional maps, and complete information will be given as to availability and condition of haul in each case. It is hoped that this survey will be useful to the State Highway engineers, to contractors for road and bridge construction, local builders and manufacturers, and owners of quarries and pits or banks of sand and gravel. One of the benefits to be derived from the project will be information concerning the availability of good concrete or highway materials, which in turn will mean a material saving in estimating the exact length of haul to any particular project so that more accurate cost estimates can be made. The suitability of local materials for certain types of construction will help to decide the most economical design to use in every case. Some preliminary work along this line was done by the Maine Technology Experiment Station and published in Bulletin No. 6 entitled "Results of Physical Tests on Maine Gravels, Rocks, and Sands." This bulletin, published in 1924, included the tests upon those samples which had been made at the University laboratories for the previous ten years. The information as therein given does not attempt to give an estimate of quantity or the exact location of the deposit. The present survey will supplement this work and give the facts lacking in this early publication. This work started early in June, and will continue for at least two years. It is believed that the findings of this survey will have considerable geological value, for Maine is most interesting in its glacial geology. At the completion of the field work a complete report, containing many maps, definite information concerning local deposits, and many interesting details about the surface geological formation of the Pine Tree State, will be compiled and published by the Maine Technology Experiment Station. This survey is one of the projects in the present plan of development of the Maine Technology Experiment Station under its Director, Paul Cloke, for the economic development of the State. Prof. H. Walter Leavitt, Secretary of the Station, has direct supervision of the work.

The New Engineering Building at the **Michigan College of Mining and Technology** is nearing completion and is a welcome addition to the facilities of the college, due to a large growth in enrollment. The building will house the Electrical Engineering department, part of the Mechanical department, and the Geology department. The first classes were held in the new Electrical laboratory the second week of the present term. The laboratory is

equipped with new electrical instruments and machines. One new instructor has been added to the Electrical Engineering department, Mr. Abas, who comes to us from the Westinghouse Company. Mr. R. F. Makens is a newly appointed instructor in chemistry, and Mr. D. E. Palmer an instructor in Mechanical Engineering.

The **Missouri School of Mines and Metallurgy** this year experienced one of the largest increases in enrollment in its history, the enrollment going to 598, an increase of 15 per cent. over the first semester enrollment of last year.

Following is a list of Faculty changes:

Dr. C. L. Dake has been granted Sabbatical leave for the college year 1930–1931 and will conduct research work in petroleum geology in Oklahoma and Texas. Dr. Dake spent the summer in the work.

Dr. J. Bridge, Associate Professor of Geology, has taken a year's leave to accept a position with the U. S. Geological Survey, and has gone to Washington, D. C., to enter upon his new duties.

W. L. Bradford has resigned his position as Instructor in English at M. S. M. to go to the University of Minnesota, where he will teach and do work towards his doctor's degree in English.

F. C. Farnham has resigned as Instructor in Physics and has been succeeded by Mr. C. D. Thomas, a graduate of the Kirksville Teachers College and the University of Missouri.

Captain K. M. Moore, for the past five years in charge of Military Science and Tactics, has been transferred to the Philippines and Lt. John R. Hardin has been transferred here to take his place.

Mr. M. W. Shepherd of Berwyn, Maryland, a graduate of the University of Maryland, George Washington University, and doing work toward a doctor's degree at Johns Hopkins, has been appointed instructor in geology, to take the place vacated by Dr. Bridge.

James S. Cullison, who received his master's degree last spring, will remain at M. S. M. as Instructor in the geology department.

A. J. Miles, who graduated in May, will remain also as instructor in Mathematics.

John M. Willson, of the class of '29 and graduate assistant in physics last year, has been appointed Instructor in Physics.

Prof. P. A. Willis has taken a year's leave as Associate Professor of Mechanical Engineering at M. S. M. to accept a position in the Examining Division of the Civil Service Commission at Washington, D. C.

Dr. Eugene A. Stephenson, formerly of Pittsburgh, Pa., where he had an office as consulting geologist and engineer, engaged in

petroleum work, has accepted the position of Professor of Petroleum Production at M. S. M., beginning this fall. Dr. Stephenson's extensive experience in the petroleum field, coupled with a successful teaching record immediately after his college days, assures the school of an outstanding teacher in this important branch, a branch that has been attracting more and more attention in the mineral industry in recent years.

Montana State College.—Mr. Harold T. Nelson, Bachelor of Science in Civil Engineering, 1930, University of Idaho, has been appointed instructor in Civil Engineering.

Merrill R. Good was elected to the Professorship of General Engineering last June. Professor Good assumed the duties of this position on September 1. Professor Good has been associated with Iowa State College for the past six years, and has been assistant professor of General Engineering for the past two years.

Professor E. L. Grant, formerly head of the Department of Industrial Engineering, Montana State College, and now associate professor of Civil Engineering at Stanford, spent the summer vacation in Bozeman.

E. R. Dye, assistant professor of Civil Engineering, was granted the professional Civil Engineering degree at the June commencement of Purdue University. Professor Dye was employed during the summer months as bridge designer for the Indiana State Highway Commission.

The Department of Civil Engineering, Montana State College, in cooperation with the State Highway Commission and the Bureau of Public Roads, held a Road Conference at the State College, in April, 1930. This conference was attended by sixty representatives from the City Engineers, the County Surveyors, the County Commissioners, the State Highway Department, and representatives from the Bureau of Public Roads and Highway Contractors. This first Road Conference was well received by those interested in road construction in the state, and it is planned to hold another conference some time during the present College year.

The forty-third annual meeting of the Montana Society of Engineers was held at the Montana State College, October 3 and 4. Dean W. M. Cobleigh served as President of the Society during the past year, and was succeeded by A. V. Corry, of Butte, in the annual election of officers.

Dean H. S. Rogers, College of Engineering, Oregon State College, was the principal speaker at the meeting. At an assembly of the Engineering Society and students of the College of Engineering, Dean Rogers gave an address on the "General Values of an

Engineering Education." At a meeting of the Society he talked on the subject, "The Social Responsibility of the Engineering Profession."

The University of Nebraska.—Associate Professor Edward Anderson, of the Department of Mechanical Engineering, has resigned his position with us, taking effect Sept. 1. Replacing him in the department, Associate Professor Walter F. Weiland comes to us from the University of Pittsburgh. Professor Weiland is a graduate of the University of Nebraska, 1918, with Master's degree taken at the University of Pittsburgh in 1923. He has taught at Pittsburgh for the past nine years.

Dr. George R. Chatburn, Chairman of the Department of Applied Mechanics and Machine Design, has been relieved of all teaching duties for the current year, on account of his health. The regents have announced his appointment as Professor Emeritus, to take effect Sept., 1931.

Dr. Chatburn has been with the University since 1894, thus having completed 36 years of service. With the exception of one year of this time, he was active in class room work regularly. During the year 1926–1927, he occupied the position of Dean of Men, for the entire University.

Dr. Chatburn's activities in the Society for the Promotion of Engineering Education are too well known to need recounting.

Mr. Harry F. Cunningham has been appointed Professor of Architecture and Chairman of the Department of Architecture. Mr. Cunningham was formerly connected with the Goodhue Associates, in New York City. He also was Professor of Design at George Washington University, lecturer on Architecture at the University of Florida, and lecturer on Theory and Composition at New York University. His architectural practice dates from 1905, and includes work for the Supervising Architect, U. S. Treasury, as well as consulting work in Washington, New York City, Florida and the devastated areas in France.

While a member of the Goodhue Associates, he had charge of re-designing the tower of the new Nebraska State Capitol.

The **Newark College of Engineering** has completed this year a new building given over largely to recitation rooms, drawing rooms and offices. It connects with the former Campbell Hall on the East and with the main Laboratory Building on the South. The building increases the capacity of the College to perhaps 20 per cent.

The Institution opened this year with a total enrollment of

about 462 students in the four branches of Engineering—Civil, Mechanical, Electrical and Chemical. The largest Freshman class in the history of the Institution numbering 175 men were enrolled. It was necessary this year to set up a waiting list as the facilities of the College are being utilized to the utmost. The new building, however, will relieve a congestion which has existed for some years.

The Mechanical Engineering Laboratory of the College has been greatly enlarged, particularly along the line of gas and oil engines of the marine and aeroplane type. The Testing Material Laboratory has been expanded considerably and the Electrical and Chemical Engineering Laboratories have been thoroughly overhauled and new apparatus installed.

Additions to the faculty this year include:

Mr. John A. Weishampel, who is an Instructor in the Department of Physics, received his education in Pennsylvania State College, taking a course in Civil Engineering, a graduate of the U. S. Military Academy at West Point, and took post-graduate work in Aeronautical Engineering in New York University.

Mr. Axel W. Berggren, who is an Instructor in the Department of Chemistry, has received degrees of Bachelor of Art from Columbia College, Bachelor of Science in Engineering and Chemical Engineer from Columbia University.

Mr. Robert W. Van Houten, who received his training at the New Jersey State Normal School and the Newark College of Engineering, graduated from the latter in the Class of 1930 with high honors and is being retained as Instructor in Mathematics. Mr. Van Houten received the degree of Bachelor of Science in Civil Engineering.

Mr. Charles J. Kiernan has been appointed to the position as Assistant to the Supervisor of Industrial Relations. Mr. Kiernan was graduated from the Newark Technical School with the degree of Associate Engineer in Civil Engineering with the Class of 1926, and has been associated for some time with municipal improvement work. Mr. Kiernan's position as Assistant to the Supervisor of Industrial Relations will embrace the placing and supervision of upper class students in the Civil Engineering Department.

Mr. Frank A. Grammer, who is an Instructor in the Department of English, holds a degree of Bachelor of Arts at Lafayette College, and has majored in English and minored in Education and Psychology in that College.

The **New Mexico College of Agriculture and Mechanic Arts** is experiencing by far the greatest enrollment in its history. Especially is this true in the School of Engineering where the number

of students is mounting to a point nearly equal to that of the combined registration of the other schools. This increase came with such unexpectedness that the entire freshman schedule has had to be revised upon a semi-platoon system to take care of the new men. A beautiful new Spanish patio type dormitory for men has just been completed and dedicated. But it is already completely full, as is also the girls' dormitory. Foster Hall, a splendid new building of Spanish-architecture, named after an early president of the College, now a resident of Las Cruces, is just being completed and occupied by the Department of Biology, the Extension Department and some of the departments of the School of Agriculture. This building will give only temporary relief. President H. L. Kent is thus being forced to seek additional appropriations to enlarge the physical equipment of the College to greatly augmented demands upon it. On December 31 last, Dean R. W. Goddard of the School of Engineering died as a result of coming in contact with high tension sending circuits of the College radio station KOB. This was particularly tragic as KOB has been started by him as the earliest educational institute broadcasting station, as well as possibly the earliest of all radio stations in the country. From a simple beginning he had developed it into the most powerful of all college stations. Dean Goddard left a place in college and community that can hardly be filled. Dr. James T. Rood comes from Wisconsin as the new Dean of Engineering. Gilbert L. Shew, graduate of Rose Polytechnic, is a newly added instructor in mechanical engineering. The College broadcasting station KOB has had its output raised from 10,000 to 20,000 watts. In order that its sending radius may be increased to correspond, new towers are to be erected. Leased wires for national programs will give the station additional effectiveness.

Northeastern University.—The faculty of the day division has been augmented by the addition of seven new members: Brandon Trussell has been appointed Assistant Professor of Economics; John C. Morgan, Instructor in Coordination; Elmer E. Haskins, Instructor in Mathematics; Norris W. Potter, Jr., Instructor in English; DeLano G. Rice, Instructor in Coordination; Brainard F. C. Hughes, Publicity Department; and Saverio Zuffanti, Instructor in Chemistry.

The Ohio State University.—Students entering architecture and architectural engineering in the fall of 1930 are beginning the new five-year curricula. The usual residence required for the bachelor's degree in these subjects has heretofore been four years.

The lengthened courses give opportunity for electives in general and cultural subjects, as well as for certain additional technical studies.

The University is prosecuting an extensive building program. A building for pharmacy and bacteriology has just been completed, and construction is proceeding on three additional buildings; a high school, to be operated under the direction of the College of Education, a men's gymnasium, and a natatorium.

The School of Mineral Industries, a grouping of the related departments of mine engineering, mineralogy, metallurgical engineering, and ceramic engineering, is described in a 32 page illustrated booklet recently issued. The importance of the mineral industries, opportunities in those fields of engineering, the School's facilities for study and research, entrance requirements of the College of Engineering, student life, and activities at The Ohio State University are major topics. The bulletin has been prepared primarily for distribution as vocational guidance material in the high schools of Ohio.

Enrollment in the College of Engineering this year is 1724, an increase of 90 over the corresponding date in 1929. The freshman class in engineering numbers 524, an increase of 15 over 1929.

Bulletin No. 50, "A Description of the Engineering Experiment Station of The Ohio State University," has just been issued. The purposes of the Station, special laboratories and equipment, facilities of the instructional departments available for research, and the work and accomplishments of the Station are discussed in detail. The appendix lists the Station publications and projects, the research staff, and the roster of engineering experiment stations in the United States and includes the law establishing the Station and the standard forms for cooperative agreements.

The Pennsylvania State College.—The following new buildings have been completed and are now in use: A new Administration Building replacing "Old Main"; a new Mineral Industries Building; a new building for the School of Liberal Arts, and a new and very modern Power Plant.

During the last year there have been added: a new Main Engineering Building; a new Botany Building; a new Dormitory for women; and a new student infirmary.

There are ten additions to the teaching and research staff in the School of Engineering. These include Associate Professor Fred C. Stewart in Mechanical Engineering and formerly of Georgia School of Technology, five instructors, three graduate assistants in the Engineering Experiment Station and one in Mechanical Engineering.

The enrollment in engineering curricula is 1484 as compared with an attendance of 1378 a year ago—a gain of 106.

University of Pittsburgh.—Three new instructors have added to the Civil Engineering staff: A. Diefendorf, former head of the Civil Engineering Department of the University of New Mexico, as Associate Professor; Edgar D. Mosher and Thomas Williams, Instructors.

R. F. Edgar, Instructor in Civil Engineering, has been promoted to Assistant Professor; L. C. McCandliss from Associate Professor of Civil Engineering to Professor.

James A. Wasmund has been appointed Instructor in Electrical Engineering, and Henry C. Pavian, Instructor in Aeronautics.

F. H. Stiening, Instructor in Mechanical Engineering has been promoted to Assistant Professor.

E. Willis Whited, Assistant Director of Cooperative Work, has been made Director.

A new evening course in Safety Engineering is being offered this year and has aroused considerable interest among executives. The course is designed for those engaged in industrial safety work and those intending to follow Safety Engineering. It aims to place definitely the function of safety in management organization.

The School of Engineering is to have the distinction of conducting the first class in the Cathedral of Learning. The classes in freshman Drawing have become so crowded that the University officials are transferring all Drawing classes to the new Cathedral.

According to the latest figures, there is about 35 per cent. increase in enrollment in the various departments of the School of Engineering. In nearly every instance the number of freshmen enrolled is double that of last year's number. The Aeronautical Engineering Department shows the greatest increase with a 60 per cent. higher enrollment.

Princeton University.—We are pleased to announce the appointment of Professor Lewis F. Moody as Professor of Hydraulic Engineering. Professor Moody has taught at the University of Pennsylvania and the Rensselaer Polytechnic Institute, at the latter institution he was Professor of Hydraulic Engineering and resigned in 1915 to devote his full time to practice as a consulting engineer of the I. P. Morris Corporation.

During the last year Associate Professor George E. Beggs has been promoted to a full professorship, and Instructor A. E. Sorenson has been appointed an Assistant Professor.

During the summer we have added a large number of electrical

instruments to our electrical laboratory, including a General Electric oscillograph, and the Mechanical Department has added condensing equipment for a number of engines.

The old Chemical Laboratory has been remodelled to care for the materials testing laboratory and for the laboratory of industrial chemistry.

Purdue University.—On October 2, 1930, 2801 undergraduates and about 100 graduate students were enrolled in engineering at Purdue University. The undergraduate students were distributed as follows:

Chemical Engineering	392
Civil Engineering	537
Electrical Engineering	764
Mechanical Engineering	1082
Industrial Education	26

The class distribution is as follows:

Freshmen	1060
Sophomores	794
Juniors	553
Seniors	389
Special Students	5
Total	2801

We do not have the exact data on graduate students but the number is somewhat more than 100.

Engineering Research.—Attached is a list of the live projects which are being carried on by the Purdue Engineering Experiment Station. Among these are included the following types of cooperative projects:

(*a*) The American Railway Association is cooperating with Purdue University in three projects which involve an expenditure of more than $200,000 a year.

(*b*) The Utilities Research Commission of Chicago is cooperating with Purdue University in studies of insulation, lightning protection and welding. These three projects have involved an expenditure for the year of about $39,000.

(*c*) The Indiana Limestone Company is continuing its cooperative relations which have existed for the past eight years. The appropriation by the Indiana Limestone Company has been $4,000 a year.

(*d*) The Indiana Gas Association is cooperating in studies of the utilization of manufactured gas and has appropriated for this purpose $10,000 a year with a definite assurance of five years.

(*e*) The Grigsby-Grunow Company is cooperating in studies of television and has appropriated during the past year, about $53,000.

In addition to the foregoing, we have a number of smaller contracts as well as some projects which are supported by Purdue University.

New Buildings.—(*a*) The late Thomas Duncan left the major portion of his estate to Purdue University for use in additions to the electrical engineering building and for equipment. The fourth unit of the electrical engineering building is now under construction and is the Duncan Memorial Laboratory of Electrical Measurements. Due to the fact that Mr. Duncan had been a pioneer in the manufacture of electrical meters, this particular portion of the electrical engineering building will be devoted to a museum, laboratory and other rooms devoted to exhibits, standardization and research on electric meters.

(*b*) The first wing of the new Mechanical Engineering Building is completed and is being used as a steam laboratory.

(*c*) New Chemical Engineering laboratories have been constructed during the past few months to be used for instruction in metallography and special investigations which have been carried on in cooperation with industry.

Special Lecturers.—The attached program announces a series of lectures by Professor A. Lipetz who is consulting engineer of the American Locomotive Works, and also a professor of Purdue University. Purdue University is attracting non-resident and visiting professors in a variety of subjects in order to keep the students and staff in contact with trends in industry.

New Curricula Changes.—The only major change in curricula pertains to the organization of a separate option in organic chemical engineering in the curriculum of Chemical Engineering. Also, graduate instruction in organic chemical engineering is being developed to parallel the graduate instruction in gas technology, metallurgy and other branches of Chemical Engineering.

New Appointments.—Chemical Engineering: R. Norris Shreve, Associate Professor; J. W. Campbell, Assistant Professor; and Robert Heyer, Instructor. Civil Engineering: S. C. Hollister, Professor of Structural Engineering; Phillip E. Soneson, Instructor; H. G. Kemmer, Assistant; J. E. Carson, Assistant. Electrical Engineering: Clyde R. Nichols, Instructor; J. H. Karr, Instructor. Mechanical Engineering: Arthur L. Freyman, Half-time assistant; Carl M. Giltner, Half-time assistant. Practical Mechanics: C. C. Sigerfoos, Assistant; J. N. Arnold, Instructor; Warren J. Luzadder, Instructor; Frank H. Smith, Instructor. Applied Mechanics: George A. Hawkins, Assistant.

Rensselaer Polytechnic Institute.—A department of architecture was inaugurated in September, 1929. At the beginning of the second year the number of students is sixty. The head of the department is Professor Ralph G. Gulley with Ralph E. Winslow as Associate Professor. Professor Gulley is a graduate of the University of Virginia, studying also at Ecole Americaine des Beaux-Arts and at Harvard University—from the last school obtaining a Master's degree in Architecture with a scholarship, two fellowships and several prizes. He has taught at the University of Virginia and at the Georgia School of Technology and has had four years' experience in architects' offices. Professor Winslow was graduated at the Massachusetts Institute of Technology where he obtained the Bachelor and Master's degree taking at the same time several prizes.

A building for the department of architecture is now being erected at a cost of $450,000. It will contain the latest equipment for buildings of its kind. An interesting feature will be the names of fifteen of the most celebrated American architects, now deceased, cut in stone tablets set in the faces of the building.

The Shop used for the instruction of students in the Mechanical and Electrical Engineering departments in pattern making, casting, forging and the use of lathes, planers, etc., is now being enlarged to a length of one hundred and forty-four feet.

The enrollment this year is the largest in the history of the school; more than 600 new students and a total of more than seventeen hundred students.

South Dakota State School of Mines.—Assistant Professor C. F. Bowles returns after a year of study in Chicago University, having received the Ph.D. in Mathematics. Mr. Graham Walton from Mass. Inst. of Technology becomes instructor in Civil Engineering. Mr. Geo. S. Cook, University of Kansas, becomes an instructor in Mathematics. Physical Education for Freshmen was inaugurated this semester following the completion of the new Gymnasium the past year.

On June 30 **Stevens Institute of Technology** opened for its first season the new college camp in engineering which is now a part of the required course in the Freshman year. The college purchased for the camp a tract of 350 acres near the Kittatinny Range in Northern New Jersey, approximately seventy miles from the main campus at Castle Point, Hoboken. The camp buildings erected on the wooded shores of a forty-acre lake which lies within the camp property, include a mess hall, 100 feet by 40 feet in dimension, a

drafting room and administration building of two stories, and sixteen dormitory cottages. The Camp Executive is Professor Samuel H. Lott of the college faculty, and the course of instruction, both in the field and in the drafting room was controlled by Professor David L. Snader of the Department of Civil Engineering whose staff consisted of three senior and fourteen junior instructors. Field and water sports were in charge of F. J. Misar of the college Department of Physical Education. Camp closed for this year on August 9.

With the present academic year Stevens Institute of Technology introduces for the first time in the sixty-year history of the college courses leading to a graduate degree. Since the inauguration of President Harvey N. Davis in the fall of 1928, a faculty committee has been investigating the place of graduate instruction in the Stevens curriculum and on the recommendation of this committee composed of Professors F. C. Stockwell, F. J. Pond, and R. F. Deimel, the trustees last spring authorized the establishment of graduate courses leading to the degree of Master of Science. The degree will be conferred upon the completion of eighteen units of study and the presentation of a thesis in the branch of science or engineering in which the student is majoring. Courses are given during the day only and the list of courses available for 1930–1931 include advanced courses in mathematics, dynamics, economics and business methods, chemistry, thermodynamics, flow of fluids, physics, gyro-compass theory and design, electrical engineering, structural engineering, mechanism and ballistics. The enrollment in graduate courses for the first year numbers sixteen, including four men appointed from the post graduate school of the United States Naval Academy: Lieutenants Stephen K. Hall, Harry Keeler, Radcliffe C. Wells, and Gerald U. Quinn. By arrangement with the Bell Telephone Laboratories, Dr. Walter A. Shewhart of the technical staff of those laboratories, is also conducting a course on "Statistical Theories and Methods Applicable to the Economic Control of Quality in Manufactured Products" which has been opened to professionally qualified persons outside of the graduate enrollment.

At the beginning of the current academic year Colonel Elliott H. Whitlock, until then Smoke Commissioner of the City of Cleveland, became Research Professor of Mechanical Engineering at Stevens Institute of Technology to devote his entire time to smoke abatement problems and a campaign against the smoke nuisance in the metropolitan area of New York and New Jersey. Colonel Whitlock is a graduate of Stevens of the Class of 1890 who of recent years has engaged in smoke reduction, especially in Cleveland where his program has had remarkable success. Stevens Institute

of Technology is a strategic point for anti-smoke work in the New York City area for its campus at Castle Point on the Hudson opposite Twelfth Street, New York, is approximately in the center of the district of industrial cities focusing on the port of New York. The college has offered the services of its "professor of smoke" to the various government and municipal authorities, and to the manufacturers and major users of fuel in the area. Colonel Whitlock's theme is that "where there is smoke there is waste" and that the manufacturer himself can be shown how to save money by eliminating smoke. The appointment of Colonel Whitlock at Stevens follows the organization a year or more ago of the New York-New Jersey Smoke Abatement Board under the auspices of the chambers of commerce of New York and New Jersey.

Syracuse University.—Mr. F. James McCanna, who received the degree of E.E. from Washington State University, has been appointed Instructor in Experimental Engineering at the College of Applied Science, Syracuse University, to replace Mr. J. Wardlaw Porteous, resigned. Mr. Porteous is at present Instructor at St. Joseph's College, University of Alberta, Edmonton, Alberta.

Several bulletins on Aerial Photo Surveying and Mapping have been published by Professor Earl Church of the College of Applied Science. The first Bulletin is entitled "Analytical Solution of the Problem of Topographic Mapping." The second one bears the title of "Topographic Mapping from Aerial Photographs by Measurements with the Sterocomparator." The third bulletin will soon be published. A limited number of these are still available for free distribution.

It is interesting to note that the registration of 371 for the College of Applied Science this fall is 14 higher than that for last year.

Covering a period of five years, **The University of Tennessee** is expending two and a half million dollars for new buildings. For the College of Engineering a new building has been erected this year and is now in use. It was planned as a central unit of a new plant. The building is primarily designed to house electrical, hydraulic and sanitary engineering. As the center of an engineering group, the new building houses the offices of the Dean of Engineering, contains the Engineering Library and the laboratories for engineering research. The building is of brick, concrete and steel, of the most approved fireproof construction. The cost is $250,000.

A. & M. College of Texas.—New members of the teaching staff are as follows: In Civil Engineering—C. S. Adams, a graduate of

this College; and L. A. Comp, formerly with the University of Oklahoma. In Drawing Department—Mr. L. A. Breland comes from Mississippi A. & M. College, while Mr. L. M. Haupt joins the Electrical Engineering Staff after several years' experience with manufacturing and operating companies. In Mechanical Engineering—Mr. W. E. Long joins the staff as Assistant Professor and Mr. W. I. Truettner as instructor.

Additional dormitory facilities for some 300 students have become available with the completion of Hart Hall and Ross Hall, formerly used for dormitory purposes, has been assigned to the Department of Architecture for overflow of classes and as a headquarters for the Texas Engineering Experiment Station.

On Monday, September 22, the new Cushing Memorial Library was opened for inspection. This modern building designed to accommodate a library of 300,000 volumes will add materially to the effectiveness of library work.

The leaders who conducted the groups of freshmen during "Freshman Week" this session are being given the general guidance for the men of their groups through the first semester. It is hoped by this method to maintain a more intimate personal contact with the large freshman class.

Tulane University.—The enrollment in this college is larger this year than ever before in its history. The Freshman Class shows an increase over last year of 30 per cent., while the increase in the college as a whole is about 14 per cent.

In the choice of course by the Freshmen, the largest number have selected the combined course in Mechanical-Electrical Engineering.

Chemical Engineering is second, with Civil Engineering and Architecture respectively third and fourth.

The Mechanical Engineering Laboratories are being rearranged in order to secure more space for the Hydraulic Department.

Professor W. B. Gregory, head of that department, has been appointed a member of the advisory committee of the National Hydraulic Laboratory.

Mr. Powell H. Humphries has been appointed Assistant Professor of Electrical Engineering to succeed the late Mr. Miner H. Vallas. Mr. Humphries was Instructor and Research Fellow in Electrical Engineering at Harvard University.

Mr. C. Boyd Norris of Austin, Texas, has been appointed Instructor in the same department. He is a graduate of the University of Texas.

University of Utah.—The Civil, Electrical and Mechanical Engineering Departments of the School of Mines and Engineering, University of Utah, have just moved into the first unit of the Engineering Building that has just been completed. This building cost $100,000 and is a fireproof reinforced concrete structure, four stories high with ramps between stories. It contains the Electrics Laboratory on the First Floor and offices, drafting rooms and class rooms on the other three floors.

Virginia Polytechnic Institute.—Registration in the School of Engineering on October 1, 1930, was 818 as compared with 719 for the entire session of 1929–1930.

A junior college of engineering has been established in the city of Richmond through a cooperative arrangement with the Virginia Mechanics Institute. This work is in charge of H. S. Grenoble, Associate Professor of Industrial Engineering. Thirty-one freshmen in engineering were registered on the opening days. This number is in addition to those given above who are in attendance at Blacksburg.

Staff additions: Mr. H. Vance White, V. P. I., '24, has been appointed instructor in metallurgy and metallography. Mr. Hamilton Parks has been appointed instructor in architectural engineering. Teaching fellows for the year 1930–1931 have been appointed as follows: W. D. Hurst, B.S., University of Manitoba, in Civil Engineering; W. D. Price, B.S., V. P. I., and C. E. Trent, B.S., V. P. I., in Experimental Engineering; D. C. Muller, B.S., V. P. I., in Power Engineering; A. I. Neihouse, B.S., V. P. I., and I. M. McNair, B.S., V. P. I., in Electrical Engineering; Research fellows in the Engineering Experiment Station are: L. S. Neilsen, B.S., Carnegie Tech., Plumbing and Heating; E. C. Meredith, B.S., V. P. I., Sanitary Engineering.

An honors curriculum in chemical engineering has been established in the junior and senior years. A grade average of B or better is required for admission to and for continuance in the honors group.

A new mechanical laboratory, of two-story factory construction, is now being erected. This will supply 20,000 square feet of additional floor space and will house the laboratories in hydraulics and in steam and gas engineering.

The materials laboratory has been increased to 5000 square feet by the addition of space released in McBryde Hall.

Increased space has also been made available for the laboratories in ceramic engineering and sanitary engineering.

A divisional library of engineering has been established in Pat-

ton Engineering Hall with Professor W. N. Cunningham in charge.

The curriculum in Geology formerly given in the Science College has been supplanted by a curriculum in Engineering Geology in the School of Engineering.

Four units of a new group of shops are being built at the **State College of Washington.** These will house auto mechanics, forge shop, machine shop and tractors.

At **Yale University** a new Sterling professorship of Engineering has been established and Professor Walter J. Wohlenberg, M.S., has been appointed as the first incumbent with the title of Sterling Professor of Mechanical Engineering.

Professor Herbert L. Seward, M.E., has been appointed the Robert Higgin Professor of Mechanical Engineering, succeeding to the chair left vacant by the recent death of Edwin H. Lockwood, M.E., Ph.D.

COOPERATIVE ENGINEERING EDUCATION

By F. E. AYER,

University of Akron

On January 25, 1930, our engineering faculty decided to investigate the present methods pursued in cooperative engineering schools in order to appraise our own work. The colleges were apportioned to the members of the faculty who studied the catalogs and corresponded with the Deans.

Mr. P. C. Smith and Mr. E. R. Wilson took the data thus gathered and tabulated them as shown in Table I. This report is in keeping with the expressed desire of Past President Rees of bringing up to date the investigation of engineering education made by the Society. Table I is a brief comparison of the status of cooperative engineering education as given by the very able report of the committee of the Polytechnic Institute of Brooklyn and published in the March, 1927, issue of the JOURNAL OF ENGINEERING EDUCATION, which applies to 1925, and the present status of such education in 1930.

The total enrollment of cooperative engineering students in 1925 was 5550 students enrolled in sixteen schools. In 1930 we find nineteen engineering schools using the cooperative method with a total enrollment of 9550 or an increase of 70.8 per cent. in students and 18.6 per cent. in number of schools. The 5550 cooperative engineering students in 1925 was 10 per cent. of the total number of engineering students enrolled in this country. In 1930, the 9550 cooperative students is 13.5 per cent. of the total number of engineering students enrolled or an increase of 3.5 per cent.

Comparing the amount of school time in weeks as given by the different institutions we find that in 1925 there were two schools giving less than a total of one hundred weeks; one giving eighty-four and another ninety, with an average for the sixteen schools of 118.5 weeks. In 1930 there is only one school giving less than one hundred weeks, and that one gives ninety-six weeks of school instruction. The average for the nineteen colleges operating in 1930 is 120.7 weeks.

Referring to the length of alternating periods there is now a decided trend toward a longer period of alternation. In 1925 there were two schools with a two-week period and two with a three-week

TABLE I

College		Yrs. Required	Coöp. Work Begins	Length of Alternating Periods	Total Coöp. Time	Total School Time Wks.	Ratio Coöp. School Wks.	Total Coöp. Enrollm.
U. of Akron	'30	5	2d sem.	9 wks.	113	115	.98	245
	'25		1st yr.	3 wks. or 6 wks.	123	106		146
U. of Cincinnati	'30	5	1st yr.	4 wks.	123	107	1.15	1,609
	'25							1,144
Detroit Institute of Technology (Y.M.C.A.)	'30	5	2d mo.	4 wks.	130	100	1.30	198
	'25			2 wks.	139	90		88
U. of Detroit	'30	5	1st yr.	4 wks.	115	115	1.00	1,270
	'25			2 wks.	124	107		400
Drexel Institute	'30	5	2d yr.	12 wks.	84	132	.64	851
	'25							498
* Evansville College	'30	5	9th mo.	3 wks. or 6 wks.	110	119	1.00	104
	'25							95
Fenn College Cleveland	'30	5	1st yr.	5 wks.	124	112	1.10	280
	'25							
Georgia School of Technology	'30	5	5th wk.	4 wks.	130	115	1.13	608
	'25				124	111		330
General Motors Institute of Technology	'30	4	1st yr.	4 wks.	104	96	1.08	619
	'25							
U. of Louisville	'30	4	2d yr.	12 wks.	52	132	.40	† 58
	'25							58
Marquette U.	'30	5	3d yr.	4 wks.	78	134	.58	509
	'25				72	133		447
Massachusetts Institute of Technology	'30	5	3d yr.	18 wks.	79	136	.58	233
	'25							274
New York U.	'30	5	3d yr.	16 wks.	65	144	.45	100
	'25							111
Newark Technology	'30	4	3d yr.	4 wks.	78	116	.67	405
	'25				69	116		175
U. of North Carolina	'30	4	3d yr.	13 wks.	26	142	.18	255
	'25			8 wks.	26	137		188
Northeastern	'30	5	2d yr.	5 wks.	‡ 98	110	.89	1,318
	'25							1,032
U. of Pittsburgh	'30	4	2d yr.	18 wks.	36	132	.273	446
	'25				52	131		469
Southern Methodist	'30	5	5th wk.	4 wks.	130	115	1.13	312
	'25				124	111		95
U. of Tennessee	'30	5	2d yr.	11 wks.	88	121	.72	130

period. In 1930 we find the minimum length of period to be four weeks with the exception of Evansville College which contemplates a change this year. There seems also to be a trend toward keeping the student in school for at least one semester before sending him out in cooperative employment.

We also asked each Dean what, in his opinion, are the chief advantages of the cooperative method in engineering education. These opinions are interesting and cover a wide range, but there is nothing in them which would add particularly to the expressions given in the report of the S. P. E. E. committee. And after all, they are only opinions and as such are of no particular value to anyone. The cooperative method is one which must be adapted to the individual institution and its industrial environment. Therefore, many of the much discussed questions, such as length of alternating periods, type of industrial experience, relative amount of time in school and industry, are all questions which must be answered by each institution.

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* May 28, 1930.

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"1. It is definitely decided that we will keep students in school one year, and it is more than likely that the following year we will change to two years of full time work, followed by three years of cooperative work. I think as this publication is going forward it would be well to make a note that we favor and are gradually adopting the two-year full time basis before cooperative employment.

"2. As regards shift duration, would state that although we operate on three weeks, at present it is quite likely that that shift will be increased to probably half a semester within the next year, that is nine weeks, alternation, half a semester. This is not definitely decidedly as the other matters above are.

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"L. B. HOYT, *Acting Director, Department of Engineering.*"

† No enrollment reported, 1925 enrollment assumed.

‡ 1 cooperative year	20	124
3 cooperative years	72	84

T-SQUARE PAGE

Research in Descriptive Geometry and Engineering Drawing

The publication of Professor Clair V. Mann's studies on the objective type of test as applied to engineering drawing and descriptive geometry marks a new high point in the development of research in technical graphics. At the Chapel Hill meeting of the Engineering Drawing Division in 1928 and at the Summer School for teachers of engineering drawing in 1930 Doctor Mann presented advance reports on his researches.

Mr. R. J. Grant of the Oshkosh Teachers College has developed a plan for training in visualization by the use of plastic clay, and has also developed a testing program to measure the degree of mastery attained by the student, as well as providing a remedial testing program for the instructor.

Briefly, Mr. Grant believes that by requiring the student to construct from plastic clay the object represented he will not only learn how to interpret drawings, how to "see" and visualize the actual object represented, but will also provide the instructor with a diagnostic check on his power to visualize.

According to Mr. Grant, plastic clay permits the student to visualize a hundred or more problems in a semester course. The clay works easily and mistakes are easily corrected. For modelling tools Mr. Grant recommends hack saw blades, cylindrical and square brass tubing for punching out holes, and kitchen knives.

The use of motion pictures in teaching descriptive geometry has been introduced by J. M. Miller of Rice Institute. At the Summer School for Drawing Teachers, Mr. Miller showed several films of propositions which he had "animated" and used successfully in teaching. The advantage to the student lies in the creation of a picture which appears to be three dimensional and which is built up point by point, and line by line in step with the explanation.

Two instructors in the Newton, Iowa, public schools have used film slides successfully in teaching drawing. A description of their method may be found in the January (1930) issue of *Industrial Education Magazine*.

Sectioning students in engineering drawing and in descriptive geometry is being studied by the Departments of Engineering Drawing at the University of Illinois and the University of Michigan. It is hoped that a condensed report of the findings of these two institutions may be published later.

THE PROJECT METHOD IN RESEARCH *

By JOHN MILLS

Bell Telephone Laboratories

In 1909 the chief engineer of the American Telephone and Telegraph Company made an extended visit to the territory of the Pacific Telephone and Telegraph Company. He found himself, as he knew he would, out of telephonic communication with his New York office. The experience emphasized anew in his mind the desirability of a more universal system of communication than was then possible, for at that time the limit of commercial service was approximately the distance between New York and Chicago.

When General J. J. Carty, who was then chief engineer, returned to New York he started the project of New York–San Francisco telephone service. In a memorandum, to the vice president to whom he then reported, he outlined the program. The first step, of extending service from New York to Denver, was immediately practicable, involving no considerable amount of research but requiring between Chicago and Denver the largest conductors then employed for telephony, loaded with suitable "Pupin" coils.

New York to Denver, however, was the practical limit without the development of a telephone repeater and of methods for adapting the repeater to the line, or vice versa, in such manner as to permit the tandem operation of repeaters at successive points along a circuit extending across the country. An electromagnetic, that is mechanical, repeater was available at the time, but in its then design and in the existing state of knowledge as to adapting lines to repeaters it could not be considered as a suitable means for transcontinental telephony.

General Carty's memorandum, therefore, which asked for more men and dollars, centered attention on the project of the development, by further research, of a telephone repeater suitable to operation on long loaded-lines. His memorandum, however, went further and pointed out that the problem of long-distance radio-telephony might expect solution as a result of the development of a satisfactory telephone repeater.

A small group of scientists was selected and research initiated. That their researches under the general guidance of Dr. F. B.

* Presented at the 38th annual meeting of the S. P. E. E., Montreal, Canada, June 26–28, 1930.

Jewett and Mr. E. H. Colpitts were successful, and that the engineering and operating problems were solved under the leadership of Mr. Bancroft Gherardi of the Telephone Company, and telephone communication between New York and San Francisco established in 1914 are matters of history, with the details of the physical developments recorded years ago in the technical literature.

The group of scientists thus assembled became the nucleus of the present research department of Bell Telephone Laboratories; and Dr. H. D. Arnold, the member of the group whose developments were most important, its present director.

A satisfactory repeater element, in the form of a high-vacuum thermionic tube evolving from the DeForest audion under Dr. Arnold's efforts, had no sooner appeared than other projects were under way. Among these the most spectacular was that of accomplishing a definite and pronounced extension in range of radiotelephony by transmission from Arlington, D. C., to Paris, France. This program, which met success late in 1915 laid the basis for the present day commercial service which the American Telephone and Telegraph Company offers between the United States and Europe.

Another project growing out of the repeater development was an extensive and still continuing series of investigations into speech and hearing in which there participated a large number of scientists, notably, Dr. Harvey Fletcher. To that project must be credited much of the present high quality and naturalness of telephone transmission and of radio broadcasting, as well as such later developments as improved sound records and systems for sound pictures.

Numerous other projects arose or evolved out of the original, for example, the multiplexing of transmission lines for the simultaneous transmission of several telephone messages by so-called carrier-current methods. In its earliest form this project met success in the simultaneous transmission of two separate telephone messages over a pair of wires connecting two rooms in Bell Telephone Laboratories or, as it was then known, the Engineering Department of the Western Electric Company. That work got underway before the transatlantic radio-telephony and, in fact, contained some of the experiments basic to that later exploit. It reached a stage of field trial in the days before the War; and served effectively in the later wartime congestion of telephone traffic.

These are not by any means the first instances of research projects; but they are the earliest and most important which it has been my fortune to observe. And because their results are so widely known and socially important they may serve as an introduction to what I have called in the title of this paper "the project method" in research. The words "project method" are obviously

taken over from primary school pedagogy with some, but not all, of those connotations. Before I attempt to develop their significance in connection with research let me describe one or two incidents which will serve as an illustration.

The director of a musical school of considerable prominence and success came into our laboratories some time ago to get information as to the equipment of a laboratory for studying the problems of acoustics which related to instruction in instrumental music and voice technique. Considering that a very full order, I asked him what particular experiment he had in mind? what particular information he was in search of? I found out he had no particular project in mind.

Somewhat similarly we received an inquiry from a physics professor in a university where they were building a new laboratory and wished to equip a portion of it for acoustical research. Again I took the liberty of trying to find out what particular experiment was in mind, with the idea of gathering from the scientists in the Laboratories the latest information as to equipment for attacking that particular problem. But there was no particular problem in mind.

These two instances are cited without reflection on the inquirers to illustrate the other extreme in research—the broad frontal attack on the unknown. Much may be said for research outlined on the plan of broadening knowledge in a certain general field. There is a certain Baconian satisfaction in looking at a whole field of human knowledge and in classifying and trying to extend it. This is probably the justifiable attitude of "pure" research and the project method may be characterized, or stigmatized, as peculiarly fitting to industrial research with its necessity of justification for its expenditures and its hope of ultimate financial reward. Projects, on the other hand, are not always to be commended; for example, there was the inquiry which we received for equipment to permit a "study of the relation between metabolism and the carrying power of the voice."

The adoption of a project permits a unified and coordinated research program; it adds direction, prevents scattering of effort and rolls up ideas, methods, techniques and results with a cumulative effect like that of compound interest. The research grows and branches like a tree, with new shoots and budding problems springing from the last season's growth. Its roots meanwhile reach farther and farther back into the fundamentals of the sciences upon which it depends, entering new ground, tapping new veins of knowledge and venturing into a dark unknown.

It was out of the project method that came the important physical discovery by Dr. C. J. Davisson that a stream of electrons

is diffracted by a crystal as if they were a beam of waves. A pure science discovery, but in effect a result of the interest of Bell Telephone Laboratories in the project of obtaining more cheaply the electrons which are so useful in vacuum tube devices, and hence, pushing back still further into the unknown, in an interest in knowing more about electrons.

There is, of course, always the danger that a project may be too narrow, but I believe that the inconvenience of that method is rather that it turns out to require too large a variety of training and experience for its completion. Few projects are limited to a single field of science. Sooner or later the workers must cross the arbitrary boundaries between chemistry and physics; between electrical engineering and mechanical engineering; between physics and biology or psychology, and sooner or later there may enter an economic interest or motive. The chemist interested in wood preservation for poles and crossarms becomes a biologist experimenting with fungus growths; the telephone engineer approaches the phonetician, and the radio engineer may turn meteorologist and a student of the ionized upper layers of the atmosphere.

Motivation is usually keener when effort can be centered on some definite project. The growth of research is then a more or less natural evolution, guided somewhat perhaps by pinching off inopportune buds or failing to give financial nourishment to shoots which do not promise rapid and firm growth.

The very fact that projects do so grow and enlarge calls for some systematization and coordination. There is a call also for common interest and cooperation between specialists in apparently widely separated sections of science. A project permits to individuals a variety of selections and assignments to different phases of the main problem in accordance not only with scientific training and experiences, but with temperamental interests and personal peculiarities as well. The experimentalist and the theorist, the designer, the operating technician, and the more routine worker, each finds a part in a well coordinated attack on a sizeable project.

Perhaps because the project method is so peculiarly the method of engineering industry it should appeal to technical schools. In most instances they serve a certain community of the public, state bounded or otherwise, not only in the education of its members but even more importantly in the development, storing and passing on of scientific knowledge of value to that community. A project comes to my mind which happens to have been undertaken in the Laboratories, from which I must draw most of my illustrations, but might equally well have been chosen by any American technical school, particularly those in the South. I mean the investigation into the factors underlying textile insulation and the resulting dis-

covery that proper washing of cotton would make it an insulator superior to ordinary silk. The apparatus required for that investigation was relatively simple, the ingenuity considerable, and the ultimate financial savings promisé to be very large.

That the project method has proved serviceable in industrial research will be rather generally admitted. The question of how far it should be applied in academic activities however, is one to which the answer is not so obvious. About all that can be justly urged at present, it seems to me, is the need, because of its industrial success, for consideration of the method by educators.

It is, of course, only one method of systematizing research. Whether or not research should be systematized, or rather how far such efforts can go without endangering the results, is also a matter for deliberation and judgment. In your consideration of that question I wish you could all read a short paper on the subject by Dr. H. D. Arnold, as presented before the Sigma Xi chapter at Columbia some time ago. With that in mind I have had the paper reprinted and copies may be obtained by addressing the Bureau of Publication of Bell Telephone Laboratories.

The project method, as I am using the words, may now be summarized as the method of systematizing research in which a rather definite objective is established and the research activities of a group of workers coordinated towards its accomplishment. The objective may be quite specific but it should not be too narrow since, according to the present concept, it must enlist a considerable group of workers and a wide variety of interests. Recognizing our American peculiarities of temperament, I should be inclined to say also that the objective should have some probability of economic and social value as well as of scientific importance. Such probability will, I believe, prove stimulating rather than embarrassing to those engaged on the more scientific phases of the project; and at the same time it attracts the larger groups whose interests lie in practical application and utilization and in human and economic relationships.

When, however, one considers projects on large scientific, economic and social scales one recognizes immediately that there may be difficulties in the organization, for the attack, of the loosely related and largely autonomous departments of a university. The answer may lie in allowing the project to evolve both in its technical aspects or direction and in the organization of its workers. If it has been well chosen—if, in other words, it has value and interest, it may be counted upon to attract workers to its various phases, particularly as it gets underway and success seems probable.

Industry has indicated the possibility of such evolutionary development. Although, in our laboratory work for example, it would have been possible in many instances for executives to have

coordinated departments likely to be concerned long in advance of the need, it has, I believe, usually been found that the best method was to allow the proposed project to evolve. A single department usually initiated a project under, of course, executive approval. Then as need for advice and investigations by other groups of scientists or engineers arose those departments were included and money was assigned proportionately for their activities.

Although there are, of course, vital differences between industries and universities in organization, in point of view, financial arrangements and incentives, each may learn from the other as to the attack on research. In fact industry has so learned and profitted, and frequently admits publicly its debt to the universities of the world. What part of the methods of each may be transferred or adopted is, of course, open to question, to analysis, and very probably to a pragmatic solution by trial and error. All that is attempted in this paper, and all that is hoped for, is again to direct the attention of educators, interested in research, to the project method.

GETTING STUDENTS TO LEARN *

By FRANCIS T. SPAULDING

Associate Professor of Education, Harvard University

Some years ago a flippant student at one of our large universities published a book called "Pedaguese." As its title implied, the book was concerned with the language which professors of pedagogy are reputed to use in dealing with their subject. The book pretended to be a "trot." Its left-hand pages contained long and involved excerpts from the writings of prominent teachers of education; its right-hand pages offered alleged translations of the excerpts into straight-forward English. The left-hand pages were almost uniformly packed with solid print. The right-hand pages, in striking contrast, were nearly always brief: they set forth at most two or three somewhat obvious ideas in simple language. The book reached its climax in a number of masterly left-hand pages—pages black with erudite "pedaguese"—faced by right-hand pages which were entirely blank.

People who are not themselves intimately concerned with the professional study of education seem in many cases to have formed their opinions of education as a subject of study through the reading of some such book as this. Some have apparently read chiefly from the right-hand pages—the purported "translations" of educational dicta—and have concluded that the study of education has little or nothing to offer for the improvement of teaching. Such people are likely to hold that mastery of subject matter is the only essential prerequisite to good teaching, though a modicum of common sense and an agreeable personality are desirable supplementary qualities. There is, I think, more than a little evidence that they are mistaken. Others have apparently read exclusively from the left-hand pages, and have concluded from them that education is fast on the way to become a science of magic. Persons who have faith in many of the current advertisements of correspondence courses—in the virtue of copyrighted schemes for training the will or in the possibility of learning to speak French like a native in six easy lessons—must rest their faith on some such belief in educational magic. There is abundant reason to believe that they too are mistaken.

* Summary of a discussion presented at the Civil Engineering Session of the Summer School for Engineering Teachers, Yale University, July 1, 1930.

Whether the study of education can defend as real contributions all the educational findings that are couched in "pedaguese," or whether these findings are, in fact, only an abstruse reiteration of common-sense, I do not pretend to judge. So far as this present discussion and those which are to follow it are concerned, I can promise to set forth no new and magical practices in teaching, and no shortcuts to perfection. The job of learning presents, I suspect, about as hard a row to hoe as it ever did, and the job of teaching is only somewhat less difficult than it used to be. Teaching is, in a sense, somewhat less difficult, because the study of education, while providing no shortcuts, has shown us that certain "common-sense" practices are superior to other practices also supposed to be based on common-sense. It is with a number of common-sense practices as we now understand them that I propose to deal—practices which are already familiar in a measure to most teachers, but upon which the study of education has thrown interesting light.

From the day he starts teaching to the day he retires, every teacher finds himself confronted with the problem of getting his students to learn. He may seek to avoid the problem by denying that it exists—by maintaining stoutly, as is the habit of many college and university teachers, that his duty as a teacher requires him merely to set before his students the things they ought to learn, and that the responsibility for learning those things rests with the students themselves. But even though a teacher denies the problem he does not cease to be interested in evidences of whether his students *do* learn—in their marks on his examinations, their records in courses which follow his, even in the size of his class-enrollments from year to year. And when the evidence that he has not got his students to learn becomes sufficiently impressive, even the teacher who disclaims his responsibility in the matter is likely to search for ways to make his teaching more effective. What are the best ways of getting students to learn when the students themselves avoid responsibility for learning?

There is one easy and obvious answer to this question—so easy (apparently) and so obvious that it is likely to be the first resort of the teacher in distress. There occurs an excellent illustration of this answer in a chapter of Ian Hay's "The Lighter Side of School Life," in a description of a class in an English public school. Though Ian Hay is writing about secondary-school pupils instead of college or university students, and about a course in Greek and Latin instead of a course in engineering, he describes a method of teaching which is likely to be thoroughly intelligible to any teacher of any subject, and which is eminently worth considering.

"Mr. Dumaresq was reputed to be the hardest slave-driver in Eagles-cliffe. His eyes were cold and china blue, and his voice was like the

neighing of a war-horse. He disapproved of the system of locked form-rooms—it wasted at least forty seconds, he said, getting the boys in—so he made his head boy keep the key and open the door the moment the clock struck.

"Consequently, when upon this particular morning Mr. Dumaresq stormed into his room, every boy was sitting at his desk.

"'Greek prose scraps!' he roared, while still ten yards from the door.

"Instantly each boy seized a sheet of School paper, and having torn it into four pieces selected one of the pieces and waited, pen in hand.

"'*If you do this,*' announced Mr. Dumaresq truculently, as he swung into the doorway, '*you will be wise.*'

"Every boy began to scribble madly.

"'*If you do not do this,*' continued Mr. Dumaresq, '*you will not be wise. If you were to do this you would be wise. If you were not to do this you would not be wise. If you had done this you would have been wise. If you had not done this you would not have been wise.* Collect!'

"The head boy sprang to his feet, and feverishly dragging the scraps from under the hands of his panting colleagues, laid them on the master's desk. Like lightning Mr. Dumaresq looked them over.

"'Seven of you still ignorant of the construction of the simplest conditional sentence!' he bellowed. 'Come in this afternoon!'

"He tossed the papers back to the head boy. Seven of them bore blue crosses, indicating an error. There may have been more than one mistake in the paper, but one was always enough for Mr. Dumaresq.

"'Now sit close!' he commanded.

"'Sitting close' meant leaving comparatively comfortable and secluded desks, and crowding in a congested mass around the blackboard, in such wise that no eye could rove or mouth gape without instant detection.

"'*Viva voce* Latin Elegiacs!' announced Mr. Dumaresq, with enormous enthusiasm. He declaimed the opening couplet of an English lyric. 'Now throw that into Latin form. Adamson, I'm speaking to YOU! Don't sit mooning there, gaper. Think! Think!

Come, lasses and lads, get leave of your dads—Come on, man, come on!

—And away to the maypole, hey!

Say something! Wake up! How are you going to get over 'maypole'? No maypoles in Rome. Tell him, somebody! "Saturnalia"—not bad. (Crabtree, stand up on the bench, and look at me, not your boots.) Why won't "Saturnalia" do? Will it scan? *Think!* Come along, come *along!*'

"In this fashion he hounded his dazed pupils through couplet after couplet, until the task was finished. Then, dashing at the blackboard, he obliterated the result of an hour's labour with a sweep of the duster.

"'Now go to your desks and write out a fair copy,' he roared savagely.

"So effective were Mr. Dumaresq's methods of inculcation that eighteen out of his thirty boys succeeded in producing flawless fair copies. The residue were ferociously bidden to an 'extra' after dinner. Mr. Dumaresq's 'extras' were famous. He held at least one every day, not infrequently for the whole form. He possessed the one priceless attribute

of the teacher: he never spared himself. Other masters would set impositions or give a boy the lesson to write out: Dumaresq, denying himself cricket or squash, would come into his form-room and wrestle with perspiring defaulters all during a hot afternoon until the task was well and truly done. Boys learned more from him in one term than from any other master in a year; but their days were but labour and sorrow." *

Is not this the answer to the problem of getting students to learn? Let the teacher be eternally vigilant in seeing that his students occupy themselves only with their classwork in his class periods; let him set him standards high; let him insist inexorably, under pain of penalties which really hurt, that those standards be lived up to by every one of his students—let him, in other words, simply *make* his students work—and may he not confidently expect that boys will learn "more from him in one term than from any other master in a year"? And if the days of those boys happen to be "but labour and sorrow," will not the boys themselves at length value their learning more highly on that very account?

Probably the reply to these questions will be "yes," if one does not look too closely at the results of compulsion as a method of getting students to learn. Most of us who have gone successfully through high school and college can recall at least one Mr. Dumaresq in our own experience—a teacher whose courses we are proud to have "passed," and from whom we confidently believe that we have learned much more than from our other teachers, though the process of learning may have been far from agreeable. The great majority of our teachers are likely, as a matter of fact, to have relied largely upon some such method of compulsion, so that instead of being unique a Dumaresq stands out for us merely because he has compelled more urgently and more conscientiously than the rest. It is only when one seeks to discover what sort of learning the compulsion has brought that one becomes fully aware of the defects of this method.

It happened that a few years ago I served for a time on the Board of Freshman Advisers of Harvard College. The members of this board are responsible, among other things, for guiding students' choices of courses during their first year in the College. In the case of most entering students the choice of Freshman courses is to some extent determined in advance by certain Rules for Distribution of Courses adopted by the Faculty. These rules provide that during his college career each student must elect at least one full course from each of four specified fields; and since students were urged to take as many of these courses as possible during their first year, and since the appropriate courses in three of the four

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fields were usually obvious in the case of any single student, the problem of advising students in this matter was never highly involved. But certain difficulties appeared in connection with the choice of courses in science, which was one of the required fields. Physics, chemistry, biology, botany, zoölogy, geology, and meteorology, all were open to Freshmen, and a laboratory course in any one of these subjects would satisfy the requirement of a course in science. It seemed to me reasonable, at first, to suppose that a student who had had an introductory course in science as a part of his secondary-school work would be interested in electing a college course in science in the same field. Hence to students whose entrance records showed satisfactory work in high-school physics I would suggest Physics C as an elective; to those who had passed in high-school chemistry I would propose second-year college chemistry. But it soon became apparent that a continuation of their high-school work was the last thing that most of these boys wanted. Those who had presented physics for entrance evinced a surprising ambition to inquire into the complexities of college chemistry; those who had studied chemistry in high school wanted to take up physics in college; and the few who had already studied both physics and chemistry were all athirst, so they claimed, for an elementary knowledge of geology or meteorology or a like science not taught in high schools. Most of the boys—those who had barely passed for admission as well as those who had gained honor grades in their entrance examinations—professed themselves much interested in the science courses they had studied in high school and anxious to change their fields of study only because of what they had heard about specific college courses. But occasionally some statement came out which seemed nearer the truth, as, for example, in the case of the boy who said bluntly: "I don't know what meteorology and zoölogy and that sort of truck is all about, but if I've got to take one of them I suppose I've got to. I'll sign up for any one of them you say. But I had physics and chemistry in high school, and believe me! you couldn't get me to take any more of that stuff on a bet!"

An instance of this sort proves nothing. It may, however, give point to a serious doubt as to the effectiveness of a method of teaching which consists for the most part merely in making students work. That the present system of entrance requirements for the Eastern colleges does lead teachers to rely largly upon such a method, few who are acquainted with existing conditions will deny. Here were boys who were products of the method. They were boys, too, who had learned more in one term than had many of their classmates in a year—else they could never have survived the competition that admitted them as Freshmen to Harvard College. Yet

in spite of their success, their most earnest ambition was to have nothing further to do with the things they had learned, and to keep as far away as they could from courses which would give them more of those things.

It would be possible to multiply illustrations of this sort almost indefinitely, in the case of nearly every phase of our high-school and college curricula. Teaching through compulsion—merely by "making students work"—may produce learning of the sort that enables students to pass satisfactory examinations. It may even produce learning which a student retains and finds valuable, providing the student is placed subsequently in situations in which he is forced to have and use that learning or to fail. But teaching through compulsion is likely always to be working against itself, even when it seems superficially to be most effective. It works against itself, in the first place, by creating the strongest possible distaste for the things that are learned—a distaste which impels any but the most exceptional student to have done with those things as soon as may be. It works against itself, also, by creating distaste for the process of learning, so that only by more and more compulsion can its victims be got to learn. It goes far, in a word, toward insuring the solution of the problem of getting students to learn, not so much by getting the students to learn as by getting speedily rid of the students who do not care to learn.

Compulsion alone, then, easy and obvious though it frequently seems as an answer to the problem, is likely to be of no very permanent value. Clearly there must be some other way out if the teacher is to be successful not merely in getting his students to learn, but in getting them to use what they learn and to go on learning more. What that way out may be will be suggested, perhaps, by a brief examination of certain fundamental conditions which always exist when a student is learning under the guidance of a teacher. There are at least three such conditions which the teacher must recognize if his teaching is to be thoroughly effective.

The first of these is perhaps almost too obvious to need statement: *the student's coöperation in his own learning is essential.* The student cannot be expected to learn except as he is willing to go through at least the motions of learning—except, that is to say, as he is to some extent interested in the learning in question or in what he expects to derive from it.

The second condition is less obvious. It involves, indeed, a flat contradiction of the position of those teachers referred to earlier, who maintain that responsibility for whatever learning students may do rests wholly with the students themselves. *The teacher is primarily responsible for securing the student's coöperation in learning.* That teacher is not doing full justice to his task, in other

words, who does not seek to make his students willing to go through the motions of learning—who does not attempt to awaken the active interest of the students either in the learning itself or in the results of learning.

Consider briefly the situation with which any teacher is confronted when he meets any class of students. He could classify his students, if he would, into three groups according to their interest in the subject matter with which he is dealing.* One group would consist of students already actively interested in the subject, as a result of their acquaintance with it either in the course in question or in previous courses. A second group would consist of students who were neutral toward the subject—who held no prejudice against it, but who had not yet found in it anything to enlist their active interest. The third group would contain students who were positively hostile (of whom there may be some in almost any course) —students who had entered the course under some sort of compulsion, and who had learned from previous experience, either in that course or in similar courses, to expect nothing but boredom or worse from it. With these three groups of students the teacher is faced, in the expectation that he will develop to the full in each student, through his teaching, such potential abilities as each one may have in the subject matter with which the course deals.

Assume, now, that the teacher undertakes no responsibility for the attitudes of his students, but simply lays his subject before them. If no sort of compulsion is present, the achievement of each student is likely to be directly in proportion to his interest in the course. He will learn just so much as his prejudice leads him to find agreeable, and no more; and the dull but interested student will probably far exceed in accomplishment the potentially capable but hostile one. For the results the teacher in question will truly be not responsible: it will be some previous teacher, or some casual experience on the part of individual students, which will have determined the interests of his students and will thus have determined the success of his teaching. If, moreover, the teacher is completely successful in avoiding any appeal to the interest of his students, he runs serious risk of strengthening whatever disinclination to learn may already have been present—of making interested students either neutral or hostile, of driving formerly neutral students into active hostility, and of confirming already hostile students in their low opinion of the whole business.

Were the potential capacity of a student in a given subject fairly measured by his interest in that subject, these effects might

* This method of classifying students according to their interests was brought to my attention by my colleague, Professor Bancroft Beatley, to whom I am indebted for much in the present instance.

not be so unfortunate. Together with the result of a little compulsion in learning, judiciously applied according to the methods of Mr. Dumaresq, the deadness of the teaching would doubtless speedily bring about the elimination of the least interested and hence supposedly the least capable students, leaving the teacher free to cultivate to the utmost the presumably superior abilities of those who were interested in spite of him. But it is not true that potential ability and present interest in learning necessarily go hand in hand. Lack of interest does not of itself mean lack of capacity, and there is abundant evidence that neutral or even hostile students, if once their interest in a subject can be aroused, have capacity to do well in it. If the teacher is under any obligation whatever to see that his students profit from his teaching according to their potential capacities, he cannot be indifferent to their interest in learning. He must, indeed, consider the development of his students' active interest in the subject matter with which he deals one of his primary concerns as a teacher.

Thus for the second of the essential conditions which the teacher must recognize: the teacher himself is primarily responsible for securing the student's coöperation in learning. The third is closely related to the second: *the student's coöperation in learning is most effective when the teacher's purpose and the student's purpose are identical*—or, in different words, when the student wants to do what the teacher wants him to do because the student is thoroughly interested in the undertaking in question. What this third condition means in terms of definite teaching practice may be illustrated, negatively at least, by reference once more to Ian Hay's account of Mr. Dumaresq's class.

Mr. Dumaresq was deeply concerned that every boy in his class should give constant attention, and complete attention, to the business of the classroom. That business, he recognized, was not the only thing to which a normal boy might attend: temptations to look out of the window, to talk to other boys, to seek relief in disturbances of one sort or another, to take advantage of any sort of diversion, were always present. He sought, therefore, to build a wall around each boy which would shut out the possibility of every sort of activity but one—the activity involved in studying Greek and Latin. His wall consisted in part in providing something for every boy to do from the very moment he entered the classroom. "He made the head boy keep the key and open the door the moment the clock struck. . . . 'Greek prose scraps!' he roared, while still ten yards from the door." The wall was fortified by an arrangement for "sitting close," which "meant leaving comparatively comfortable and secluded desks, and crowding in a congested mass around the blackboard, in such wise that no eye could rove or

mouth gape without instant detection." Its final reinforcement was the energy and determination of the teacher—his hounding of the pupils through the whole class-period, his provision for "extras," his willingness to "wrestle with perspiring defaulters . . . until the task was well and truly done." Clearly Dumaresq had here as nearly hole-proof a construction of its sort as one could well expect to find.

And yet it was by no means holeproof. Adamson sat and mooned. Crabtree looked at his boots. The class as a whole demanded constant prodding, driving, urging. And the explanation is not hard to find. The wall which Dumaresq erected did indeed make it difficult for his students to give attention to anything except the work he set before them, but it made it by no means impossible for them to attend to other things, and it made those other things certainly no less attractive by comparison. Moreover, it changed the students' intentions not at all. Their intentions were readily apparent: to do their work if they had to, in order to avoid the unpleasantness which would follow their not doing it, but to do not one whit more than they had to in order to escape that unpleasantness. The question that was uppermost in the mind of every boy was not how to do his work to the best of his ability, but how to avoid doing as much of the work as he could possibly get out of.

Dumaresq, to be sure, adopted purely negative means for keeping his students' attention—means paralleled in our colleges and universities by the rules against "cutting," the probation lists, the penalties for failure in examinations, the interviews with the dean, the exercise of suspension and expulsion, which occupy so large a place both in faculty minutes and in collegiate tradition. Dumaresq (and the colleges) might perhaps have hoped for greater success through a more positive sort of urging—through rewards for high scholarship, prizes for excellence in competition, diplomas or certificates formally endorsed. But even such spurs as these offer only a half-way promise. They are likely to be effective with a few students only; and even for those to whom they do appeal they result again in the creation of a divided interest. The student who is working for a prize, like the student who is exerting himself to keep off probation, finds the standard of his accomplishment dictated for him by the immediate purpose that he has in view. He will devote to his studying just so much interest and attention as he conceives necessary to "get by" in terms of that purpose; and with the purpose once achieved, the learning that has made its achievement possible is of no more importance and will in all probability be quickly forgotten. Nor is there any condemnation here implied for the student in question. He would be an unintelligent

student indeed who, electing to play the game, failed to observe the rules.

If compulsion alone will not work, and if compulsion and rewards together promise only half-way success, what can the teacher do? There would seem to be only one thing: to make his teaching itself of so much interest to his students that for the time being, at least, it will outweigh immediate sources of distraction. The teacher who can do this need build no wall to prevent the wandering of his students' attention: the students will of themselves attend to the things they are interested in learning. The teacher who can do this need, moreover, have little fear that his teaching will be dismissed from his students' thoughts as soon as his course is over: he may expect, indeed, that they will hold as fast as the limitations of the human mind will let them to what they have learned, and try to get more. Thus it is in seeking to develop his students' whole-hearted interest in his subject as he teaches it—in trying to get his students to want to do what he wants them to do because the undertaking in question is itself interesting to them—that the teacher is likely to be most successful in getting students to learn.

But this is not, unfortunately, the whole answer to the problem of getting students to learn. To show the paramount importance of students' interest in their work is in a sense no very difficult task. To show just how that interest may be aroused and maintained is quite another matter. The latter task presents, indeed, a problem which may properly tax the resources not alone of the general student of education but of the specialist in subject matter. Since I am myself merely a generalist, with no background in the study of engineering, I cannot hope to give an immediate answer to the question in terms of the subject matter of engineering courses. I can, however, suggest certain methods of teaching which have commonly proved valuable in getting students to learn, and which are of such a nature that they can in all probability be readily adapted to the needs of the engineering curriculum.

The most effective teaching is likely, as I have pointed out, to be teaching which arouses the active interest of the student in the subject matter itself. There are at least three major ways of arousing such interest.

One way, paradoxically enough, is not to attempt to rouse interest directly, but to take advantage of interests already present—to *base the teaching as largely as possible on pertinent questions or problems proposed by the students.* The effectiveness which this method frequently achieves springs in part from the fact that matters about which individual students are curious enough to raise questions of their own accord prove in many cases to be matters

which are of interest to other students as well. Questions proposed by students themselves, moreover, frequently arouse more wholehearted interest than do even the same questions propounded by the instructor. One is immediately well-disposed toward what one thinks of as one's own. Hence a course which treats of such questions gives promise of meeting the interests and needs of the students concerned much more directly than does a course organized quite arbitrarily (from the students' point of view) by the instructor.

This method presents certain complications, however. It demands of the instructor an unusual degree of skill in stimulating his students to raise questions freely, and in adapting to the purposes of the course the questions which happen to interest them. It is likely to result, moreover, in teaching which from the instructor's point of view frequently lacks coherence and unity, and which may omit important items of subject matter, since the units which are taken up are determined by the disconnected and often somewhat irrelevant "spontaneous interests" of the students. Strict adherence to a prearranged course of study, if it means neglect of worthwhile immediate interests expressed by the students, ought obviously never to be insisted on. Yet teaching which is solely guided by students' chance curiosity is no less to be avoided. Hence this single method presents at best only a partial answer to the problem. This much it suggests: that the teacher should be continually alert to stimulate pertinent questions by his students, and that whenever significant questions arise, no matter from what source they may come, he should base his teaching directly upon them even at some sacrifice of systematic procedure.

But the teacher need never be content, fortunately, merely to wait till "spontaneous interests" happen to dawn upon his students. He has it in his own power to create interests quite as "spontaneous" to all appearances, and hence quite as impelling, as the interests which his students come upon by chance. The secret of doing so is to be found in the second of the three major ways of getting students to learn. Briefly stated, it involves simply *"setting the stage" to call forth the proposal of pertinent questions by the students.*

A single illustration of this method will perhaps serve to make it clear.* In a certain course in high-school chemistry the instructor wished to introduce to his students the phenomenon of catalysis. The Dumaresq procedure in such a case would have been simple; he would have had only to assign careful study of certain pages in the textbook, and to insist on thorough mastery of the information

* For this particular illustration I am indebted to Professor Thomas H. Briggs of Teachers College, Columbia University.

which those pages contained. But having become convinced that procedure of the Dumaresq type would be undesirable, the teacher in question adopted a quite different method. He produced in class one morning, without explanation or comment, a pocket cigarette-lighter of a type then in some vogue, which operated through the ignition of alcohol vapor by a catalytic agent brought in contact with the vapor. This lighter he lit, and blew out, and lit again, and blew out, and then started to return it to his pocket. At that point one of his pupils asked to look at it: he gave it to him, showed him how to operate it, and let other pupils crowd about. Various pupils had theories as to how the thing worked. The theories were wrong: the teacher showed them that there was no battery connected with the lighter, no flint, no spark, and no apparent heat until the alcohol was ignited. There were "spontaneous" questions from all sides: "Then how *does* it work?" Whereupon the class began the study of catalytic agents.

There are many phases of the engineering curriculum, I suspect, which will lend themselves readily, in the hands of a moderately ingenious teacher, to such "setting the stage." Demonstrations of unfamiliar processes or of cleverly designed apparatus are likely to be particularly effective in connection with this method. Accounts by the teacher of engineering achievements or engineering phenomena which arouse the students' curiosity through qualities of newness or strangeness may provide an equally promising approach. And the method has in its favor the fact that it need involve no dependence on the merely chance interests of the students, while at the same time it may result in getting the students to learn with as much enthusiasm as if the teacher had taken his cue directly from the students themselves.

There remains still a third way of developing students' active interest—a more obvious way, perhaps, than either of the other two, and yet one which is in many respects more difficult to apply with full success. It consists in *directly proposing topics or problems for study so chosen and so presented as to appeal to students' "natural" interests.* It involves, that is to say, no attempt either to "set the stage" or to ferret out questions which the students themselves happen to have in mind. Instead, it consists simply in proposing a subject for study—"Today we are going to deal with a phenomenon called catalysis"—and in dealing with that subject in such a way as to make it appeal immediately to the interests which all normal people possess: curiosity, liking for the colorful or dramatic, interest in the better understanding of the commnplace or familiar, or any other of that whole range of satisfactions which are so widespread that they are often popularly supposed to have an "instinctive" basis.

The obviousness of this method is amply demonstrated by the fact that it is the method—frequently the only method—which most teachers use. Used by itself, it has the advantage that it allows strict adherence to whatever course of study and whatever time-allotments the teacher finds desirable. In the hands of a skillful teacher, moreover, it may prove to be nearly if not quite as successful as the other methods in holding the students' active interest. But its probable success is exceedingly difficult to gauge in advance. Whether the students will be interested in the learning which it demands of them depends in part on whether the teacher's announcement of the problem itself awakens interest. Does "catalysis," for example, mean enough to the students in question so that they look forward with any sort of positive curiosity to a further understanding of it? If it does, then the mere announcement of the subject may be all that is necessary for a successful beginning. The students' interest depends in part also on their previous experience with study under the particular teacher in question. No matter what "catalysis" may be, have they found in the past that whatever this teacher proposes for their study is likely to be thoroughly worth studying? If so, then here too this method may be successful. But if the teacher is to be able to choose subject matter which in itself awakens the interest and attention of his students, or if he is to deal with that subject matter in such a way as to hold their interest and attention, he must have given long and thoughtful study both to his students and to what he is to teach them. He must know the kinds of things in which his students are likely to be interested—both the things that can be counted on to interest them "naturally" as a group, and the things that may perhaps appeal to certain individuals. He must know also just where, in the whole range of subject matter with which he deals, such things are to be found. And there is no sure way, so far as I know, by which this knowledge can be acquired except through actual trial. The ability to propose problems which will appeal to students' interests, and to deal with those problems in such a way as to maintain the interest which has been aroused, is likely to come only through endless experimentation—through trying out various types of subject matter with various types of students, year by year, and in each case noting the results.

These, then, are three ways to get students to learn: base the teaching on pertinent questions which the students themselves propose; "set the stage" to create active interests; propose subjects for study so chosen and so presented as to appeal to "natural" interest. To the best of my knowledge these are the most effective ways, whether in the teaching of engineering or in the teaching of

any other subject. Their merit lies in the fact that wherever they can be successfully used they result in an attitude toward learning which leads students not merely to learn for the moment, but to hold on to what they learn and to go on learning.

If, as teachers, we had sufficient command of our subjects and sufficient understanding of our students, we might find in these three ways of teaching alone a complete answer to the problem of getting students to learn. But unfortunately both for us and for our students, few of us have at present enough skill in teaching to make these methods alone suffice. We can interest all of our students some of the time in the subject matter which we present to them; we can perhaps interest some small number of our students all of the time; but we find ourselves inevitably confronted with at least some students and some subject matter which quite fail to take to each other despite our best efforts. Must we, then, be content with only a half-way performance?

I have suggested at an earlier point that certain extrinsic interests—rewards, competition, approval of various sorts—may result in getting students to go through at least the motions of learning. Extrinsic interests are never as valuable as interest in learning itself. Since they have, strictly speaking, nothing to do with the things that are learned, they are likely to reduce learning and the direct results of learning merely to an insignificant means, which can be put aside and forgotten as soon as the goal is attained. But extrinsic interests may often make the "motions" of learning less disagreeable than they might otherwise be—may sometimes make them even positively agreeable; and there is always the chance that if the student can be led to go earnestly and not too disagreeably through these motions, he may at length discover the value that rests in the learning itself. Hence it may be worth while to suggest briefly the kinds of extrinsic interests to which students are likely to respond.

Varied and interesting methods of conducting class work represent one kind. The mere fact that students can look forward to occasional relief from the monotony of the lecture method, for example, may do much to make the job of learning more satisfying. Class procedure which gives the students, as well as the teacher, opportunity to be active, may be especially fruitful. Whatever their value as direct teaching devices, group discussions, student reports, class demonstrations, class "excursions," the use of the "case method," the employment of class time for carefully guided study or elementary research, all may provide possibly fruitful sources of interest. Particularly if no one method of teaching is used to the exclusion of others, the mere way in which the class work

is carried on may be an important factor in stimulating students to learn.

The use of attractive illustrative materials may represent a second source of extrinsic interest. Models, diagrams, charts, maps, photographs, have a possible contribution to make toward teaching technique which has by no means yet been fully explored. We may, perhaps, overestimate their worth in many instances as a means of making things clear, but they serve at least to vary the usual purely oral or written presentation of things to be learned. Combined with verbal illustrations which lessen the formality and the possible bleakness of classroom presentation, they may frequently serve as strong immediate incentives to learning.

A third source of interest is to be found in various types of appeal to students' pride in their own accomplishment—through prizes, marks, examinations, and rewards of various sorts, and especially through competition. There is danger in the extensive use of such means as these because of the false motives and false standards of appraisal which they frequently involve. Competition in particular may have exceedingly serious results. There is more than a little reason to suspect, for example, that the "cut-throat competition" which is often deplored in the business and professional world takes more than a little of its spirit from the competitive attitudes fostered in many of our schools. Yet there is no denying that pride in accomplishment may be one of the most impelling forces which the teacher has at his command; and used with due regard to its dangers, it may have exceedingly worthwhile results in the classroom.

Still a fourth type of interest may spring from the activity and attractiveness of the teacher himself. Strongly though the professional student of education may deplore the theory that successful teachers are always born and never made, he cannot wholly deny that the successful teacher is likely to have certain qualities which we do not at present know how to "make." Many of these qualities are summed up under the blanket term "personality." But the classroom personality of the good teacher, like the "bedside manner" of the successful doctor, comprises certain things that can be "made." The habit of standing before a class instead of sitting, for example, is a habit which can be acquired; so can the habit of moving about (but not too much), of speaking clearly, of varying one's inflections; so also can the habit of dressing so that one's students may find one "easy to look at" (but not too easy). And all of these things have a part to play in determining whether the job of learning is something to be resisted or something to be undertaken with at least moderate acquiescence.

Finally, direct appeal to a student, or even to a class as a whole,

may sometimes be effective. To learn because someone else wants one to learn, or expects it of one, may not represent the highest type of motive; yet the results of learning thus motivated may be better than the results of no learning at all. Direct appeal does, in any case, represent one possible means for getting students to go through the motions of learning; and the teacher whom students thoroughly respect, and whose high opinion they care for, will often find this means of value.

I have attempted, in listing these major sources of extrinsic interest, to keep always in view the fact that they are means merely for getting students to go through the motions of learning. Getting students actually to learn—if by learning we mean more than "cramming" for a final examination—must always involve awakening their active interest both in the learning itself and in what is being learned. Appeals to extrinsic interests alone can never be counted on to secure this result. Such appeals may, it is true, produce an outwardly convincing show of activity. They may even produce that sort of pseudo-learning which is measured in terms of ability to hand back without fail the verbal subject matter of a given course. But they are, by their nature, unconnected with the subject matter itself, and unless direct interest in the subject matter is somehow aroused, they will succeed only to the extent of producing a mere semblance of learning.

Hence the task of getting students to learn demands the use of two types of appeals. The teacher must first do all in his power to bring out whatever interest is inherent in his subject itself. If he is successful, he will get many of his students—perhaps most of them—to learn through these direct means. But he has always to deal with a certain number of students, sometimes large and sometimes small, for whom he has been unable to make his teaching carry any direct appeal. For such students he must have recourse to the more casual sources of extrinsic interest. Yet for these students also the interest of the subject matter itself must be emphasized, if they are eventually to be added to the number of those whom the teacher has truly succeeded in getting to learn. The measure of the teacher's success is, indeed, the number of his students for whom extrinsic appeals are no longer necessary—the number, that is to say, who learn because they want to, and who go on learning long after their school and college diplomas have been duly signed and sealed.

Is this at length the answer to the problem of getting students to learn? In a world in which teachers were omniscient and omnipotent it might well be the answer. But teachers have limitations, and students are refractory; and at least as often as now

and again it happens that these methods simply do not succeed. What then?

Why then, I think, *make the students work.* Permanent interest usually comes, to be sure, in spite of coercion rather than because of it; so that the methods of Mr. Dumaresq ought fairly to be considered a last resort. Yet Dumaresq's methods had this in their favor—that few of his students could have left his course without respect for the course and for the standards which it upheld. And if Mr. Dumaresq had done more than simply coerce—if he had put his effort as well into an attempt to awaken his students' interest in the subject matter which he was teaching—the learning born of coercion might in some few cases, perhaps, have been at length recognized by its possessors as interesting and valuable for its own sake.

The teacher who grants his own full responsibility for getting his students to learn must recognize his obligation first of all to get them to learn voluntarily. He will need to use to the utmost whatever power he may possess to awaken their interest in the subject matter of his teaching. He will need at the same time to use a wide variety of appeals of an extrinsic nature. If, having employed both these means, he finds himself faced with students who can learn and need to learn what he has to teach them, but who are nevertheless unresponsive to his best efforts, then he still has one further resource. He can make things unpleasant for them if they do not learn, through the various instruments of coercion which educational ingenuity has amply provided. Not until he has finally used whatever coercion may be necessary and effective has he indeed fulfilled his responsibility.

HISTORY OF THE DEVELOPMENT OF GRAPHICAL REPRESENTATION *

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Just when man became conscious of a need for some means other than spoken and written language to express ideas is not known. Nor are we apt to discover even by careful historical research the beginnings of graphical description because the record is gone; yet we may be fairly confident that graphical expression, which is now so universally recognized, must have had its beginnings long before history was recorded.

In the very nature of things it would appear that drawings of some kind must have been used to guide the ancient builders, for drawings are now, and must have always been the necessary accompaniment of constructive endeavor. No one can contemplate the work of earliest times without appreciating that there must have been a carefully thought out plan to guide the work. In just what form this plan was recorded, there is of course no record; it may have been but a crude sketch pictorially representing the idea, and leaving much to the initiative and imagination of the builders; or it may have been an artistic rendering dealing largely with appearances and meagerly with details; or it may have been a cryptic expression based on a system of description now lost like the languages of the ancient tribes; yet these representations served and functioned much as do modern drawings, if results may be used as a measure.

It seems not unreasonable to believe that Tubal Cain—who is alleged to have been the first teacher of shop work according to Genesis 4:22—set up his forge on the plains of Mesopotamia and began his lessons in the working of brass and iron, he must have used some means of graphical representation to convey his ideas. These may have been no more than crude diagrams in the sand, yet they served a purpose. Nor does an examination of some of the archaeological discoveries from the biblical cities of Palestine leave one in doubt about the ability of an ancient people living as early as 2000 B.C. to portray a story in graphical form. Meager as such

* Presented at the Engineering Drawing and Descriptive Geometry Session of the Summer School for Engineering Teachers, Carnegie Institute of Technology, June 20, 1930.

evidence is concerning the beginnings of a science which is now a controlling force in human enterprise, yet it is all that remains to show that even in those early days the spoken and written language needed to be supplemented.

The first positive evidence which definitely establishes the fact that drawings were used to guide constructive undertakings, is found in the writings of Vitruvius (63 B.C.–14 A.D.) who states—"The architect must be skilful with the pencil and have knowledge of drawing so that he readily can make the drawings required to show the appearance of the work he proposes to construct, . . ."

Other references in Vitruvius definitely establish the fact that draftsmanship was recognized and that drawings were the method used to convey structural ideas.

In about 100 B.C. Frontinus, who became "Curator Aquarum," relates how he had *plans* made of the Roman aqueducts.

In commenting upon these facts, Professor Alexander P. Gest states: "I have no doubt that there must have been at least a practical knowledge of drafting among the Greek and Roman engineers, and it is hard to imagine the Greek geometers without some sort of Descriptive Geometry."

Of the drawings of Leonardo da Vinci, more is known: that he understood and practiced representation by the method of perspective, is clearly evident, but no record of representations made by what came to be known as orthographic projection remains. Not only was da Vinci a great artist, but he was also a great engineer. His treatise on painting which included an exposition of the theory of perspective, doubtless exercised a great influence on the art and artists who were his contemporaries; and his vast collection of sketch books is filled with sketches of assembled machines and their details. Whatever may some day be discovered about the mechanical proficiency of Leonardo's time, be assured from this great collection of ideas so marvelously expressed in graphical language, that he forecast the mechanical development of the years which followed.

In 1587 projects for the publication of Leonardo's manuscripts began, but it was 1651 before the treatise on painting which contained his exposition of the theory of perspective was published. This date fixes the first publication of the theory of projection. This theory was of course, scenographic projection; of Leonardo's knowledge of orthographic projection—if indeed he had any—there is but slight evidence.

Reference is made in Usher's "The History of Mechanical Inventions" to a "selection from the mechanical drawings" in Leonardo's various manuscripts, and relates how these passed from one owner to another, from Italy to Spain, to England and

back at last to the Ambrosian library at Milan in 1636, where they remained until the invasion of Napoleon. "They were then brought to Paris and many of them never returned." Whether the "mechanical drawing" referred to here means graphical representation of the type now called orthographic representation, or whether "mechanical drawing" in connection with Leonardo's work means graphic representation by the method of scenographic projection made with *mechanical aids,* is not clear; the latter assumption seems more likely to be the case.

It is not so essential to establish in this record the type of graphic representation used at this period, as it is to establish the very important fact that during Leonardo's active life—from 1475 to 1516—he practiced and taught a method of graphical description which had for its direct purpose the recording and conveying of ideas on mechanical subjects.

Passing now to the period which followed Leonardo, and preceded the discovery of the science of orthographic projection, some evidence is to be found showing that drawings even then were commonly used in constructive work. While most of the references are to "architectural drawings," and most of the structural activity of that period centered around public buildings and civil engineering works of a public character, there is reason to believe that graphical representation was the common source of information used to guide the work.

There was in existence a few years ago, a set of drawing instruments bearing the date 1701, which in many details bears a striking resemblance to our modern high grade sets. In workmanship alone, here is testimony concerning the age of drawing of a striking character; for these tools obviously were the product of many years of use and development, both in the art of instrument making and in the art of draftsmanship for which they were designed.

In 1715 Brook Taylor published the first book in the English language on perspective which was entitled: "New Principles of Linear Perspective, or the art of designing on a plane the representations of all sorts of objects in a simpler method than has yet been done."

In 1726 Batty Langley published the first book on what has developed into Engineering Drawing. The book, a beautiful example of printing—hand set type, and hand made paper—is called "Practical Geometry, Applied to the useful arts of Building, Surveying, Gardening and Mensuration." It is calculated for the service of "Gentlemen" as well as "Artisans," and contains four parts, the most significant being: "The various orders of architecture, laid down and improved by the best masters; with ways of

making draughts of buildings, gardens, groves, fountains, etc., the laying down of maps, cities, lordships, farms, etc."

The book is illustrated by copper plates engraved "by the best hands" and is indeed remarkable and delightful proof that long before descriptive geometry was even discovered, mankind recognized how difficult a subject it was destined to become. According to B. Langley in 1726: "The subjects of the present treatise, on account of their *antiquity*, usefulness and entertaining variety, having been the delight of the greatest masters in knowledge, thro' various ages, are, it must be acknowledged, transmitted to us in a suitable degree of perfection. They have indeed been largely treated of by various hands, but generally in a theoretical, rather than in a practical manner, so as to appear somewhat intricate and obscure to such as were not acquainted with the principles of mathematics, or have not applied themselves in earnest thereto. My design therefore is to treat of architecture, gardening, mensuration and land-surveying, in a method as easy and intelligible as it is new and generally useful. I shall begin with the fundamental, or first principles of these several arts, and gradually conduct my reader from the easiest parts of 'em up to the hardest, taking particular care all along to let him see the *utile* as well as the *dulce* thereof; the fruitful practice, and not the barren theory only. From a failure of authors in this point, I apprehend it is that these arts are at present much less cultivated than they merit. An author cannot do them greater justice, than to paint them as they are, most useful and delightful employments; of great importance in human life. To convince the world of this truth, as it is the design, so it wou'd be the highest recommendation of the present treatise. And this I can sincerely say, that I have had a view thereto thro' the execution of the whole design. I shall not therefore offer any recommendation of the arts themselves, which want no able hand to set them off with colours, and the winning charms of rhetorick; but leave my reader, from the plain, naked, artless facts and observations he will meet with in the work, to determine of their merit. And I am greatly equitable, and more unexceptionable procedure than to write, as the usual manner is, an encomium of arts I treat of, in order to recommend the work. For if the book cannot be supported by its own merit, I am sure a panegyrick upon its subject will but render it the more ridiculous and contemptible. All that I request is a fair and candid perusal. I desire only that my reader wou'd come with a mind prepared not to be startled, or prejudiced against the author, by the appearance of novelty back'd with reason; tho' it at first sight shou'd seem to thwart some current and prevailing opinions. This were a temper that wou'd forever exclude the light, and dronishly remain con-

tent with whatever doctrine happens to have its run. But we of late have seen such successful inrodes made into opinions once thought just, that we cannot be too suspicious of our entertaining establish'd errors for truth, and shutting our eyes against plain fact and obvious reason. 'Tis not that I pretend to a faculty beyond that of others in discovering the truth in the particular subjects I have here treated; but my genius leading me to such kind of studies, I hope I may be allowed to have observed the common things and to make my own use of them. If what I alledge to be true, (for which I always give my reasons) the world will have the advantage; but if it shall prove to be false, I shall willingly bear the blame: Only I make this request, that I may be censured by the proper judges, and such as have been conversant in the same kind of studies with my self; otherwise the world, I hope, will agree with me, that I am condemn'd unjustly. That the reader may form the better judgment of the performance, he may be pleased to take the following account thereof.

"Geometry being the basis of architecture, gardening, mensuration and land-surveying, (which are the subjects of this treatise) I have in the first part, laid down all the most useful and necessary geometrical definitions, problems, theorems, and axioms, that are absolutely necessary to be well understood by every one who desires to be a complete artisan, and those in a most concise and familiar manner. The second part contains the application of the first to practice in the geometrical construction of all kinds of scales for the delineating, and mensuration of all sorts of plans and uprights, and of the *Tuscan, Dorick, Ionick, Corinthian, Composite, French* and *Spanish* Orders of architecture, with their derivation, proportion, etc., in general. And seeing that neither ancient or modern architects have yet agreed on the measures of the principal parts of entire columns: I shall therefore before I proceed any further, demonstrate the same particularly."

Commenting upon the forces which gave rise to the discovery of the science called descriptive geometry, Alexander W. Cunningham in his "Notes on the History, Methods and Technological Importance of Descriptive Geometry" states: "Architecture and stone masonry have always necessitated the study of geometrical drawing. I am aware that Mr. Fergusson in his History of Architecture (page 665) ignores the idea of any great attention having been paid to graphical designs in the erection of the early Gothic Cathedrals. But it appears to me that Mr. Fergusson, in maintaining (what is probably quite correct) that the nomadic masons were not the architects of these Cathedrals, but that the Bishops, abbots, and accomplished laymen, 'not specially educated' to the profession of architecture, and qualified only by 'talent and good

taste,' fulfilled this office, goes too far when he says that, 'without making drawings, guided only' by general directions as to the plan and dimensions, the 'masons might proceed with the work.'

"I cannot, however, afford space to discuss such questions, but the remark of Lorenzo de Medici, already referred to, is worthy of note. Mr. Fergusson, however, referring to Masonry itself, says (page 666)—'When freemasonry became so powerful as to usurp the designing as well as the execution of churches, there was an end of all art, though accompanied by some of the most wonderful specimens of stone-cutting and constructive skill that ever were produced.' Now this art of stone-cutting deserves to be particularly mentioned as having given birth to many ingenious, graphical, and constructive operations, more especially as, for obvious reasons, it was practically associated with the art of dialling. Geometrical methods, both graphical and constructive, which in the middle ages and early modern times had been cherished as secrets pertaining to the masonic craft, were in the 17th and 18th centuries expounded in treatises on the art of stone-cutting.

"I regret that it is impossible for me at present to notice the development of graphical geometry with respect to Shipbuilding, an art especially dependent on scientific means of graphical representation. I pass on to Fortification. . . .

" . . . Accordingly, towards the close of last century, the French mathematician MONGE was led, from the consideration of certain problems in fortification, to generalize all the isolated method hitherto employed, not merely in fortification, but in perspective, dialling, stone-cutting etc., into a theoretical code, which he termed *la Géomètrie Déscriptive,* and which was designed to supply the means of—(1st.) preparing on uniform principles the working drawings necessary in the various arts; and of (2d.) graphically solving problems in solid geometry, by general methods, capable of the most extensive practical application.

"The name of Monge is so inseparably associated with Descriptive Geometry, and the development on this basis of French technical education, that I need offer no apology for giving some account of his life and labours. The best notice of these which I have met with, in any English work of reference, is that contained in the old Penny Cyclopaedia. Those who desire fuller particulars should consult DUPIN'S *Essai historique sur les services, et les travaux scientifiques de Gaspard Monge* (Paris, 1819). Indeed I may say that this work deserves the attention of every one who wishes to understand the growth of the French system of technical education.

"GASPARD MONGE was born at Beaune in 1746. Having early given evidence of distinguished mathematical talents, both as a

student and teacher in the College at Lyons, he obtained an appointment as draughtsman in the military school at Mezieres. Here he distinguished himself by his geometrical solutions of questions in Defilade (Defilement), a term given to the general problem of securing in the design of a work of defence, thrown up on an irregular site, the utmost amount of cover compatible with a certain moderate 'relief' or height. 'By applying,' says Dupin, 'his mathematical talents successively to different questions of an analogous character, and generalizing in every instance his modes of conception and operation, he succeeded at last in establishing a code of doctrine—his Descriptive Geometry. . . . But how many obstacles had he to overcome before he could overthrow the scaffolding of a mass of incoherent practices, and substitute for them a simple and general method, which left no longer a vantage-ground for charlatanism, or an asylum for the mysteries of empiricism!' . . .

"Now so great was the admiration accorded to Descriptive Geometry on its first promulgation by Monge, that many were disposed to regard it as a real means of extending the science of Geometry. This, however, is not the case. The mistake arose probably from overlooking the fact that a large amount of rational geometry was necessarily mixed up with the exposition of mere descriptive operations; and, more particularly, from not clearly perceiving that truths may be deduced from the *Theory* of projection, without any necessity for graphically exhibiting them by the *Methods* of projection."

Coincident with the development of the science of orthographic projection, came the beginnings of "the interchangeable system of manufacturing," and the establishment of technical education in the United States.

Even while Monge was pleading for the study of descriptive geometry, as a means of stimulating manufacturing in France, Thomas Jefferson, then Minister to France, in 1785 wrote in describing the manufacturing of guns: ". . . it consists of the making of every part of them so exactly alike that what belongs to any one may be used for every other musket in the magazine. . . ." In another letter written later to President James Monroe, Jefferson stated that Le Blanc, a French mechanic, had extended his system and that he, Jefferson, was hoping to get him to come to the United States. That Jefferson grasped the advantages of this system of manufacturing is evident from these early letters, that his interest continued is shown by a quotation from a letter he wrote in 1801 about Eli Whitney: "He has invented molds and machines for making all the pieces of his locks, so exactly equal that take one hundred locks to pieces, and mingle their parts, and the one hun-

dred locks may be put together by taking the pieces which come to hand."

In England during the period just preceding and following Monge's discovery, such men as Sir Christopher Wren, Smeaton, and Telford were making use of the empirical knowledge of their times in describing graphically cathedrals, light houses, and public works. Smeaton is known to have taken down the interior walls of a cooperage in order to lay out on the floor his design for the Eddystone Light which he began in 1757. Telford lived long enough after the publication of Monge's work to have been influenced by it, for in connection with some of his work in 1821 a three view drawing was printed. During this period, there seems to be abundant record to show that drawings were used in connection with public work of an architectural and civil engineering character, but we should credit James Nasmyth (1808–1890) for his influence in applying this new language to the description of machinery.

The story of the steam hammer that Nasmyth sketched in 1839, is now a classic, but of his ability as a draftsman the following is of interest: "James Nasmyth was the tenth in a family of eleven children. Like all of his brothers and sisters, he inherited his father's artistic tastes. If he had not become an engineer he would probably have become distinguished as an artist. To the end of his life his skill with his pencil was a constant source of pleasure and convenience. The notebook in which the later record of his mechanical ideas is contained, is crowded with funny little sketches, landscapes, little devils and whimsical figures running in and out among the calculations. . . ."

In France and in Germany Monge's descriptive geometry became very quickly a part of the national education plan, and in 1816 Claude Crozet introduced the subject into the educational scheme of the United States at West Point. After graduating at the Polytechnic School in Paris, Crozet had been artillery officer under Napoleon. From 1816 to 1817 he was assistant professor of engineering at the Academy, and from 1817 to 1823 full professor. E. D. Mansfield has given us some interesting recollections of Crozet's earliest teaching at West Point.

The junior class of 1817–18 was the first class which commenced thoroughly the severe and complete course of studies at the Academy. Of Professor Crozet, Mansfield says that he was to teach engineering, but when he met the class he found that he would have to teach mathematics first, as not one of them had had the necessary preliminary training in pure mathematics for a course in engineering. "The surprise of the French engineer, instructed in the Polytechnique, may well be imagined when he commenced

giving his class certain problems and instructions which not one of them could comprehend and perform." "We doubt," says E. D. Mansfield ,"whether at that time more than a dozen or two professors of science in this country knew there was such a thing (descriptive geometry) ; certainly they never taught it, and equally certain there was no textbook in the English language."

This science, founded by Monge, was then scarcely thirty years old. Crozet meant to begin by teaching this branch, but a new difficulty arose. Just then he had no textbook on the subject, and geometry could not be taught orally. What was to be done? "It was here, at this precise time, that Crozet, by aid of the carpenter and a painter, introduced the blackboard and chalk. To him, as far as we know, is due the introduction of this simple machine. He found it in the Polytechnic of France."

In 1821 Crozet published his *Treatise on Descriptive Geometry,* for the use of cadets of the United States Military Academy at West Point, thus antedating all but the original books on the subject. The first eighty-seven pages were given to the elementary principles, and the next sixty-three pages to the application of descriptive geometry to spheries and conic sections. This is, according to our information, the first English work of any importance on descriptive geometry and the first book published in this country.

Even before descriptive geometry was introduced into the curriculum at the Academy, Christian Zoeller was made instructor of drawing in 1807. Later he was made professor and is doubtless the first teacher of drawing in our first school of engineering. Probably on the walls of West Point is a more complete record of the stages through which graphical representation has passed, than exists anywhere in this country. Although it is recorded that Christian Zoeller was an instructor of drawing at West Point in 1807, it must be remembered that painting and other forms of graphical expression were then taught to the embryo soldiers and among these records on the walls of West Point is a sketch by Whistler, who was once a cadet.

During the years 1802–1824, the United States Military Academy established the beginnings of engineering education in this country. At the same time in New England the technique of interchangeable manufacturing applied to guns and locks by such men as Whitney, North, Jerome, and Colt was creating a demand for scientific knowledge. This demand was amplified by conditions following the war of 1812: The exhaustion of the soil by unscientific methods of agriculture, the demands for better systems, the trend toward new lands in the West, all tended to focus attention on the need for scientifically trained leaders.

Commenting upon this situation Dr. Charles R. Mann, in Bul-

letin No. 11 of the Carnegie Foundation for the Advancement of Teaching, on *A Study of Engineering Education* states: "In spite of the wide-spread recognition of the need, the Rensselaer Polytechnic Institute remained for twenty-three years the only school of its kind. At length in 1847, thru private benefactions, the Lawrence Scientific School was established at Harvard and the Sheffield Scientific School at Yale. The University of Michigan also voted the same year to offer a course in civil engineering. These were the only* additional engineering schools opened before the Civil War, and they had a hard struggle for existence because their aims seemed dangerous to academic traditions.

"During the Civil War Congress passed the Morrill Act (1862) granting federal aid to the several states for founding colleges of agriculture and mechanic arts. State legislatures that had for years been deaf to all appeals now quickly accepted the federal grants and voted to create the new type of school. Established colleges caught the spirit and added departments of engineering. The four schools of 1860 increased to seventeen by 1870, to forty-one by 1871, to seventy by 1872, and to eighty-five by 1880."

The importance of drawing and descriptive geometry in these pioneer civil educational institutions was early recognized and in 1849 the revised curriculum of Rensselaer devoted four courses scattered throughout the three year curriculum to drawing and descriptive geometry; in 1865 the Massachusetts Institute gave two courses in drawing and two courses in descriptive geometry; in 1867 drawing was mentioned in the curriculum of the University of Illinois, twice, descriptive geometry twice, and shades, shadows and perspective once. Among "the qualifications requisite for a candidate for the degree Civil Engineer" the Rensselaer school stated: ". . . he must be perfectly familiar with plotting and business drafting."

Of the teaching of descriptive geometry, at these institutions and of the ideals and objectives of the pioneer teachers: Crozet, Davies, Church, and Warren, fortunately there is adequate record in the prefaces of their valuable books on descriptive geometry. Of the teaching of mechanical drawing, as it was beginning to be called, very little is known until the middle of the nineteenth century.

In 1834, T. Sopwith, an Englishman who described himself as a "Mine and Land Surveyor," published a treatise on *Isometrical Drawing*, which method of representation he advocated as applicable to ". . . perspective views and working plans of building and machinery." In this excellent book the author clearly

* Union College offered courses in engineering in 1845, and Brown University in 1849.—AUTHOR.

demonstrated his knowledge of orthographic projection, and advocated isometric *drawing* in preference to isometric *projection*, and that he favored isometric representation as having "many peculiar advantages which cannot be obtained by any other method." While we are not now concerned with Sopwith's championship of isometric drawing, we are enlightened thereby because his thesis no doubt was the outgrowth of a need for a *better* method of graphic representation than was commonly used. And this we may infer from the following: "For Plans and Elevations of Buildings, and for working details of Machinery, Isometrical Drawing possessed such decided advantages, that a more extended knowledge of its principles cannot fail to ensure its almost universal application, in preferance to every other mode of *perspective drawing*."

That a need for textbooks existed at this time, is voiced by Wm. Minifie, who published one of the earliest books on drawing which might be called a textbook. In 1849 Minifie states in his "Geometrical Drawing": "Having been for several years engaged in teaching Architectural and Mechanical Drawing, both in the High School of Baltimore and to private classes, I have endeavored without success, to procure a book that I could introduce as a textbook: works on Geometry generally contain too much theory for the purpose, with an insufficient amount of practical problems; and books on Architecture and Machinery are mostly too voluminous and costly, containing much that is entirely unnecessary for the purpose. Under these circumstances, I collected most of the useful practical problems in geometry from a variety of sources, simplified them and drew them on cards for the use of the classes, arranging them from the most easy to the more difficult, thus leading the students gradually forward; this was followed by the drawing of plans, sections, elevations and details of Buildings and Machinery, then followed isometrical drawing, and the course was closed by the study of linear perspective and shadows; the whole being illustrated by a series of short lectures to the private classes. . . . In conclusion, I must warn my readers against an idea that I am sorry to find too prevalent, viz.: that drawing requires but little time or study for its attainment, that it may be imbibed involuntarily as one would fragrance in a flower garden, with little or no exertion on the part of the recipient, not that the idea is expressed in so many words, but it is frequently manifested by their dissatisfaction at not being able to make a drawing in a few lessons as well as their teacher, even before they have had sufficient practice to have obtained a free use of the instruments."

With the single exception of a slight reference to T-square and drawing-board in Langley's book on *Practical Geometry* published

in 1726, Minifie is one of the first writers to give any extensive discussion of drawing tools or of how to use them, and so far as I can learn this text bears to the subject of drawing in the United States about the same relation as does Crozet's to descriptive geometry.

The first half of the nineteenth century might well be called a formative period in the development of graphic language: the science of orthographic projection was discovered and knowledge of it was disseminated; textbooks on drawing and on descriptive geometry were written; schools were established and technical education was founded; and even more important for the future a pressing need for technically trained leaders and a growing demand for increased production focused attention upon the new sciences by means of which these ever increasing needs for expansion were to be satisfied.

The second half of this century was a period of growth, of change, of development, and of expansion so colossal and so fascinating that it deserves thoughtful study by every engineer. This era of national adolescence has been referred to vaguely and even wistfully by some as "the good old days." May I pause to point out just a few of the very high lights and very deep shadows of this epochal time?

Socially we were a people of little culture, a people of great wealth and of no knowledge of how effectively to use it. Our educational opportunities were at what would be called now a low high school level. Our ethical standards of conducting business were on a par with our political standards and both were founded on bribery and corruption.

Even as early as 1865 we were a large manufacturing nation and the enormous expansion of industry which followed the Civil War has never ceased.

Agriculture in 1870, even as now, was passing through a crisis which threatened the political stability of the country. Our national life was thrusting westward toward new land, new resources and new problems.

There was a calamitous panic, an upheaval of labor, and an industrial revolution.

Couple all this, if you will, with the tremendous effect of new inventions in steel making, in the development and application of power, in the national transportation systems, with the discovery of vast reservoirs of national wealth in coal, iron, oil, water power, and new agricultural areas, and with the benefits which were being reaped from advances in sciences, both pure and applied, and you have the situation which made the United States what it is to-day.

Perhaps the growth, the change, the development which is here

just hinted at may be more strikingly brought into the true relation it bears to the colossal economic change which was the product of this fifty years by the statement: "During the years from 1870 to 1895 the occupation of a large majority of persons employed in the production, the transportation, the marketing of almost *every article in common use,* was more or less modified."

During the period from 1850–1900 the whole scheme of graphic representation underwent the same colossal change which was common in all lines of endeavor. Military and Civil Engineering ceased to be designations sufficient to indicate the character of constructive undertakings, and engineering and engineering education became divided into branches. With each of these branches of engineering there arose a need for a kind and style of drawing in keeping with the nature of the undertaking, and thus came the day of specialization.

Along with, and stimulated by these developments and changes in the art of graphic representation, came improvements in drafting materials and instruments, the establishment in this country in 1850 of the pioneer and now sole surviving American factory for manufacturing drafting instruments by the Alteneder family, the discovery about 1840, and the introduction to the engineers of this country in 1878 of the blue print process of reproduction. During the first part of the 19th century "Draughtmanship" was an art expressing itself in fine lines, shading both by lines and by washes, ornate borders, fancy lettering and the use of colors; but with the introduction of the blue print process, all this was changed.

With this epoch-making event modern drafting came into being. The demands of the high-speed industrial organizations, of which the drafting room found itself a part, became so great that shading, fancy borders, and ornamental lettering could no longer justify the time required to execute them; drawings became plainer and even severely plain until now only that drawing which tells a complete story in the fewest lines is considered acceptable. Even the name which describes the making of a drawing has suffered from this process of pruning; the art of *draughting* has been completely lost but the business of drafting has been discovered! This change is not to be deplored, however; the function of drawing is to produce and record results, and since the results obtained by the use of modern drawings are unquestionably superior to those of earlier times, it is fair to assume that a part at least of this improvement is due to the change in drawing while at the same time it can be admitted candidly that the greater part is due to improvements in manufacturing processes. Drafting and manufacturing are so interdependent that development in the one is always accompanied by development in the other.

It was about this time that it became recognized that a drawing could accomplish what formerly had been considered, if not indeed impossible, at least impracticable—that is, infallibly to convey information to a workman; and with this fact established, model-making as an element in production became one of the lost arts.

The fact must not be overlooked that once established as the dependable means of conveying facts, drawing played an important role in establishing our present scheme of production, and as the demand upon the drafting rooms grew it must be recorded that draftsmen faced challenges at that time as stupendous as those thrown down before any group of workmen engaged in keeping pace with the colossal demands of production. More and more it was expected that information from the drafting room would be reliable, complete, and not ambiguous. More and more were draftsmen called upon to demonstrate that the so-called "unproductive" drafting room was worth what it cost. Caught as it were, between the pressure of demands for results, and the problem of securing results in the face of lowering standards among the craftsmen who were responsible for the construction, the modern drafting room passed through a formative period which was revolutionary.

Thus it was that in the late nineties the modern drafting room came into being as a part of the national industrial organization, and came to be accepted as an integral element in the scheme of production. And as a result of all this, draftsmen became conscious of themselves and of their profession.

One might almost be permitted to call this period between 1890 and 1900, the "humorous" or even "literary" period in the development of graphic language because of the pages and pages of words which were published in all seriousness about matters which now seem so unimportant. It must be recalled, however, that at this time the "college-trained" draftsman was making his first bow to the industrial world, and that he was being received by his "hard-boiled" shop-trained contemporaries with snorts of derision and a contempt born of a vague alarm that here indeed might be a new menace!

Be it also remembered that these college-trained draftsmen were far from the type we are now so proud of. These men had been trained to make drawings wonderful in appearance, they could shrink paper on the board, they could make lettering look better than news print, they could use water color and india ink wash, but when it came to making a drawing which described the shape and size of an object informing the workman simply and directly what he needed to know about finish, material, and other pertinent items, they should not be compared with that class of veterans who had

earned their places in the drawing rooms by virtue of sheer merit and long experience.

Remember too, that the textbooks of those days were written by "college men" or "professors" and no amount of quotation marks in this manuscript could convey the contempt with which their efforts were viewed by the "practical" draftsmen. Nor were these men among themselves in agreement, nor were their views always practical. Following in large measure the traditions of earlier works such books dealt generously with geometrical construction, practical descriptive geometry, exercises in the use of instruments, and meagerly, if indeed at all, with the application of such knowledge to graphical description. These "old timers" even resented somewhat new ideas as may be inferred from this comment by MacCord about drawing ink: "The best is of Chinese manufacture and comes in sticks or cakes of various sizes and forms; this is to be simply rubbed up with water to any desired density. The labor of preparation, slight as it is, is to some persons a great bugbear; and in response to their demands various 'liquid India inks' are offered for sale; the bottles, when properly cleaned, are good; which is more than can be said of the contents."

In those days draftsmen and professors alike were still arguing about the proper form of delineation, about the proper arrangement of views. This period was about the turning point of that fine old war between those who favored the *first quadrant* against those who favored the *third quadrant* method or representation. To quote one author: "By this plan the horizontal and vertical projections are made with the object at rest on the horizontal plane. To illustrate, a brick will do. First, plan, brick lying down flat. View from top shows it eight inches long, four inches wide. Second, side elevation, board shoved behind brick, and figure of brick marked on it, 2 inches high, 8 inches long. Third, end elevation, board raised on the right and figure of brick drawn on it, 2 inches high, 4 inches wide. This is the same effect as though the draftsman marked around the brick as it laid flat, then turned it up, directly on the side from him, scratched around it again. This scheme discountenanced acrobatism and all manner of inebriated posturing in the object and conserved for it a respectable representation. . . ."

Commenting somewhat tartly upon articles similar to the foregoing on projective drawing, Oberlin Smith wrote in 1895: "The writers of the recent essays upon the above seem to dwell particularly upon the doctrines of descriptive geometry, although some of them ring the changes upon other imaginative methods of conceiving what a drawing means, such as walking around the object represented, or climbing up on top of it, or burrowing underneath

it, or looking at it through transparent paper, or through glass, or having its various sides depicted upon paper which may be supposed to be wrapped around it, and which afterwards may be peeled off, after the manner of skinning an onion, etc.

"The imagination required to see things in mid-air, where they do not exist, is a very desirable quality which is posssessed as a gift of the gods by many inventors, by chess players who can conduct several games at once with their eyes blindfolded, and in a lesser degree, by ordinary geometricians, by well-trained draftsmen, by good whist players, and also (shall I say it?) sometimes, perhaps, by theologians and commercial travelers.

"It seems to me, therefore, that if we desire a simplicity adapted to untortured, if not untutored, imaginations we must totally abandon for practical work the complexity of two ideal planes and their four ideal angles, with the conception of the object seen beneath the paper instead of above it, etc. If, further, we abandon the still more puzzling ideas of walking around or climbing over the object, or unfolding its skin, we will probably come down to the simple conception of the object, or a model thereof, of the proper size, lying upon the paper. To get additional views, we must either *revolve* it directly by merely rolling it over, or, by the method last described, we must both roll it over and slide it to a considerable distance from its original position. It does not appear to me, *as probably it does not to the great army of my fellow believers, that there can be two answers to the question as to which is the simplest and therefore the best of these two methods.* . . .

"In some recent articles upon this subject, it has been stated that the majority of our best shops are now using the third-angle, or indirect method. If it be the fact that the first-angle, or direct method, has been gradually dying out, the melancholy probabilities are that it will die still more. When its disease becomes absolutely mortal, it will be only the proper thing for the army of *'direct'* people to gracefully surrender to the larger army of *'indirect,'* learning the habits of a lifetime over again, that a common practice (even if not so good as is something else, in the eyes of some of us) may obtain throughout the earth. *Such uniformity is certainly of great importance,* not only as a matter of convenience, but of actual saving of expense in the avoidance of mistakes, etc., and should undoubtedly be aimed at by all of us as early in the future as is possible.

"This question of which way to project cannot in the nature of things be of such very great importance in itself, like theology, or so many good people would not differ regarding it. Let us then all strive to come to a *common practice* in the matter and meet upon common ground of *direct revolution* if we can, or *indirect* if we

must. Let us remember, however, that America is all the time becoming less provincial and that this common ground should be *international,* rather than merely *occidental.*"

Thus, even so early as 1895, is found a far-sighted plea for standardization and for uniformity. Amusing many of these ideas of graphic representation now may seem, yet out of the unrest and dissatisfaction here expressed, gradually evolved a new period in the development of graphic representation, and a greater stability in the art of graphic expression.

Among the most *significant* and *far-reaching influences* in the development of *graphical representation* was the acceptance, early in the *twentieth century,* both by teachers and draftsmen, of the *third angle method of representation.* With the moot question of how views should be arranged, disposed of, and settled for all time, theorists and practitioners alike, turned their energies in the years which followed, to the refinement and improvement of drawing as a language. As a natural result, more and better literature on graphical representation was published both in the form of textbooks and in magazine articles during the first quarter of the twentieth century than had appeared in any similar period throughout the entire history of the subject.

Books on descriptive geometry designed to make the subject *easy to understand,* to illustrate the *applications* of descriptive geometry, and presenting the subject from the standpoint of the *third angle* appeared with almost clocklike regularity. But aside from the improvement in *presentation,* and in the study of *applications,* no great advances were evident in subject matter. *The pioneer Monge* had covered the field and one hundred and thirty-five years of scrutiny and research has added but little to his extraordinary and comprehensive achievement.

In the textbooks on drawing, however, great and noteworthy advances were made during this period. Technical education was passing out of its preliminary adolescent stages and the application of science to industry was becoming an actuality and not merely a dream.

Not only as a result of this but also because of the recognition industry was bestowing upon education in general, college trained draftsmen were finding a place in the industrial world and their influence was being felt in the literature of graphical representation. Indeed many of the teachers of engineering subjects were drafted from industry and after having learned the limitations of their own college training began a new era in technical teaching. For the first time, the whole subject of graphical representation: the theory of projection, the application of this theory to shape description, size description, and the application of shape and size

description to the general field of graphic description were joined to the old pedantic routine of geometrical drawing and the manipulation of drawing tools to make a comprehensive and adequate treatment of graphic representation.

Men like Anthony, the Reid brothers, Jamison, Fellows, and French, published books on drawing which explored the field as never before, and which adequately covered the subject in all its phases. Along with this development in drawing literature other books than texts on "mechanical drawing" appeared, and the literature of graphics began to make its appearance in books covering the fields of structural, architectural, topographic, machine drawing and, later, an even newer branch covering the subject of the technic of presenting statistical and technical data in graphical form.

For a number of years both teachers and practitioners had been feeling a mild dissatisfaction with the inherited and misleading name *"mechanical drawing,"* and with the more evident divisions of graphics into specialized branches it was inevitable that new names should appear. Professor Anthony's designation of *"graphics"* and Professor French's name of *"engineering drawing"* were both attempts—and successful attempts—to establish a fact known but never properly presented, that drawing of whatever kind, *is a graphic language,* and to each of these pioneer leaders the profession owes great acknowledgment.

No sooner had the idea of a graphic language been established, than dissatisfaction with and disapproval of the lack of standards, the absence of uniformity, and the freedom with which ideas were conventionalized began to be published, and at once received endorsement. Like the weather, a great deal was said about it and nothing at all was done until under the impetus of the "simplified practice" movement, the American Standards Association, with the Society for the Promotion of Engineering Education and the American Society of Mechanical Engineers as sponsors, organized a committee to establish standards for drafting and to bring such standards into agreement. This committee has been at work now since 1926 and is about ready to present in final form a recommendation for uniformity which in the end will make drawing what it should be—a truly *universal language.*

Reviewing very briefly the development outlined here, four rather outstanding periods are evident: *The first*—antedating 1750 and reaching back into early times—reveals little but a conviction that even in this early day the value and use of a graphical means of conveying ideas were appreciated. The outstanding event in this period is the work of Leonardo da Vinci and his contribution to the science of perspective. *The second,* one hundred years in

length, is more productive. Monge discovered the science of orthographic projection, early engineers began to use methods commonly used to-day, engineering education was established, and teaching the graphic language began.

The third period, from 1850–1900, witnessed the establishment of drafting as an integral part of the nation's production system, and the perfection and development of the materials of representation.

The *fourth* and *final* period—that in which we now find ourselves—is more significant than any. The science of graphical representation definitely is moving toward standardization, its literature is well-founded and well-defined, its teaching is on a firm basis; knowledge of its value is recognized, and its use in engineering and associated lines of activity is increasing.

What then of the *immediate future?* If the past teaches any lesson in regard to the future of graphics in general, if trends mean anything and are correctly interpreted, then the future will bring about an *increasing use of graphics* in all fields of endeavor, will witness a *wider* and more *general knowledge* of the graphic language, will insist upon *greater simplification, more abbreviation,* and *absolute uniformity* in representation. And if teachers of the graphic language are true to their responsibilities this will come about *soon* as a result of their efforts not only for the improvement of graphics as a *language,* but also as a result of their conviction that a knowledge of drawing is of value and should be acquired early in life.

OUTSTANDING ENGINEERS

Officials of the various American Engineering schools were recently asked to point out the men who have, in their estimation, been the *outstanding engineers* of the past twenty-five years; also those who might fairly be considered the *greatest engineers of all time.* We are grateful for the generous response, and also for many courteous refusals to reply to so indefinite an inquiry.

Many who have seen a tabulation of the replies have asked us whether we specified *American* Engineers. No such limitation was set, or implied.

Greatest Engineers of All Time.
78 names were mentioned.

James Watt
Leonardo da Vinci
Thos. A. Edison
William B. Eads
Ferdinand de Lesseps
Chas. P. Steinmetz
George Westinghouse
John Ericsson
Archimedes
Lord Kelvin
John L. Roebling
George W. Goethals
John F. Stevens

Outstanding Engineers of the Past Twenty-Five Years.
71 names mentioned.

Herbert C. Hoover
Chas. P. Steinmetz
Thomas A. Edison
John F. Stevens
John Hays Hammond
George W. Goethals
George Westinghouse
Guglielmo Marconi
Henry Ford
Ralph Modjeski
Benjamin G. Lamme
Michael Pupin
John R. Freeman
Clemens Herschel
Gustav Lindenthal

HENRY MARTYN MACKAY

Henry Martyn Mackay, dean of the faculty of applied science and William Scott professor of civil engineering at McGill University, died October 25, in his 63d year.

His loss is regretted by the engineering profession of the continent, having been associated as consulting engineer on many major projects of United States, Mexico and Canada, including the building of the new Harbor Bridge.

Dean Mackay early showed promise of the successful career which he was to attain in the engineering and educational worlds. He was born at Plainfield in Pictou County, N. S., in 1868. His early education was gained at Pictou Academy, following which he entered Dalhousie University, graduating in 1888 with the degree of Bachelor of Arts and honors in pure and applied mathematics.

A period in practical engineering and educational spheres followed. After graduation he was attached to the Department of Marine at Ottawa. He started his teaching career at Pictou Academy in 1889, later entering McGill University where he graduated in 1894 with the Bachelor of Science degree, with honors and the Governor General's medal for the highest standing in his year.

Subsequent to his graduation from McGill, he became principal assistant to Dr. W. Bell Dawson, who was then inaugurating a survey of tides and currents in Canadian waters. Later he became associated with the firm of Waddell and Hedrick, consulting engineers of Kansas City, and was engaged in the design and construction of bridges and other structures. During this period he was for a time in charge of the work of the firm in Mexico and superintended the construction of more than 100 bridges, including some of the biggest in that country.

In 1904 he was invited to join the teaching staff at McGill. Rapid promotion was accorded the new member of the staff, Dean Mackay successively being lecturer, assistant professor, associate professor until in 1908 he was appointed a full professor of civil engineering. Appointment as dean of the faculty came in 1924 upon the retirement of Dr. F. D. Adams.

DATES OF SECTION AND BRANCH MEETINGS

We are printing herewith a portion of a letter received from a member. The information he seeks would be of value to many institutions. Will you please send the Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa., the dates of your branch or section meetings so that this service may become a regular part of the JOURNAL OF ENGINEERING EDUCATION?

I wish you would list the forthcoming meetings of the Society for the year 1930–31. The question was asked at our last department meeting and I could not answer it. Incidentally and in that connection, would it not be very desirable to print in each issue of the JOURNAL a list of meeting dates whether of the Society as a whole or of the Sections and Branches? I have often looked through a JOURNAL in vain to find such a date. One side of one of the fly leaves could very appropriately be used for such a purpose, continued as a regular feature.

SECTIONS AND BRANCHES

The program for the October 14th meeting of the Purdue Branch of the S. P. E. E. was as follows:

Report of the Montreal Meeting—Prof. C. F. Harding
Report of the Summer School for Teachers of Drawing and Descriptive Geometry—Prof. J. Rising
Report of the Summer School for Teachers of Civil Engineering—Prof. W. E. Howland
Some Aspects of Engineering Education in the Orient—Prof. W. K. Hatt

In the election of officers which followed the program the following were names for the year 1930–1931:
President—J. D. Hoffman, Professor of Practical Mechanics.
Secretary—S. Fairman, Assistant Professor of Applied Mechanics.

TWENTY-THIRD ENGINEERS

Four thousand, eight hundred and eighty men lived together as members of one regiment for twenty months. THE TWENTY-THIRD ENGINEERS was the second largest organization of the World War, and had in it many highly trained specialists.

Most of these men have not seen each other since 1919, as their homes are in every state in the Union. Now, however, a reunion

on a large scale is being planned. To make it succeed we need the correct addresses of all former members of the regiment.

Probably some of these men read your magazine. If you feel it would be proper to do so we would greatly appreciate having you suggest in an early issue that all of our former comrades send their name and correct address to Doane Eaton, 50 Morningside Drive, New York, N. Y.

Return to the Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

Society for the Promotion of Engineering Education

Date.....

THE UNDERSIGNED desiring to become a member of

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

hereby agrees to conform to the requirements of membership, if elected and submits the following:

STATEMENT OF QUALIFICATIONS

Full Christian Name and Surname.....
Print Last Name First Middle

Mailing Address (Number and Street).....

Post Office (City and State).....

Full Title of Professional Position.....
(Title) (Department)

Full Name of Institution.....

(To be Signed by Two Sponsors)

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BOOK REVIEWS

Textbook of the Materials of Engineering. By HERBERT F. MOORE, Research Professor of Engineering Materials, University of Illinois. New Fourth Edition, xiv, 384 pp. of text, 14 pp. of Questions, 11 pp. of Index. Price, $4. Published by McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York. 1930.

This is a "thorough revision of a standard (elementary) treatment of the physical properties of the common materials used in structures and machines and includes brief descriptions of their manufacture and fabrication." The chapter on failure has been expanded into three chapters, on elastic failure, failure by creep, and failure by fracture. (The term "elastic failure" is not a happy one.) There is a new chapter on the crystalline structure of metals by Professor J. O. Draffin. A similar chapter on non-ferrous metals and alloys would be particularly useful and to be desired in future editions. The same may be said of the chapter on "Concrete" by Mr. H. F. Gonnerman. The chapter on specifications has been entirely rewritten and has been supplemented by much material taken from the "Standards of the American Society for Testing Materials."

As an elementary textbook, it is intended for use concurrent with the study of the Mechanics of Materials, rather than as a preliminary study to the latter and subsequent to the study of mechanics as covered in courses in physics. The chief objection to the book is that it tries to cover too many subjects. "Timber" is treated very well in the space devoted to it, but the two pages taken from the "U. S. Forest Products Laboratory Notes on Working Stresses" might well have been reserved for a more advanced course and text on Design, or for reference. The same is true of much of the Mechanics of Materials, as it may have the effect of discouraging the student who has not yet had sufficient training to relate the mechanics to the materials under consideration.

It is always questionable whether several (28) pages should be quoted in a textbook from such a publication as "Selected A. S. T. M. Standards for Students," or that the students be referred to copies easily available for their use, or that they be advised to purchase a copy for their own library.

The most human and enjoyable portion of the book is the statement of the "Factors and Principles Involved in the Enforcement of Specifications Based upon the 1907 Presidential Address" of Dr. Charles B. Dudley, late Chief Chemist of the Pennsylvania

Railroad, and the beloved President of the A. S. T. M. It is full of meat for both the student and the young engineer, and also for others.

The book is to be commended as a text and will prove to be useful to those teachers and students of Engineering Materials who have but a little time to devote to such a variety of subjects as the metallurgy and metallography of metals, the growth, seasoning, and uses of woods, stone-cutting, stone- and brick-masonry, the manufacture and uses of cement and concrete, rubber, and numerous other materials used by the engineer, and to the commercial and economic aspects of their choice, specification, and testing.

WM. T. MAGRUDER.

Weld Design and Production. With Particular Application to Safety and Cost. By ROBERT E. KINKEAD. Ronald Press Co., New York, 1930. Pp. viii + 108. $4.00.

The welding of metals is a very old art which has, nevertheless, had but comparatively limited use. The development in recent years of oxy-acetylene and electric welding methods has caused a great growth in the use of welded joints. These newer methods are among the most modern developments in engineering construction. By thir means pieces of metal may be joined together in a manner that is oftentimes better adapted to given conditions, or more economical than riveted or other forms of joints. As a result the growth in the use of electric or oxy-acetylene welded joints in recent years has been rapid and promises to continue.

This book does not state which welding method is considered, but it apparently pertains mostly to the gas or electric process. It is stated that the book has been written "primarily for two groups: engineers who are responsible for satisfactory and safe welds, and business executives who are responsible for the cost elements of welding jobs."

The text is very general in content and might well have been expanded to considerably larger proportions. After briefly indicating some of the applications and economies of welded joints, it devotes itself most largely to a consideration of the factors effecting the safety of welded joints in steel and to emphasizing the importance and methods of control of welding procedure to insure desired results. Practically all discussion is based on welded steel joints. Nothing is said about the welding of other metals.

The actual equipment and technique for making welds is not considered. Full information is lacking regarding some of the

tests reported. The engineer responsible for welding designs and production will miss data on many important phases of the work which might well have been included in the book.

However, in spite of the brevity of the text, it contains many very good points and a valuable discussion of tests in Chapter VI. What the author has to say regarding predicting the behavior of welded joints and his consideration of the costs of failure will prove interesting and suggestive to the designing engineer. The "engineers and business executives" who have to do with welding will find the book decidedly worth reading.

A. C. JEWETT.